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BULLETIN No. 57.

U. S. DEPARTMENT OF AGRICULTURE.
DIVISION OF CHEMISTRY.

PROCEEDINGS
OF THE
SIXTEENTH ANNUAL CONVENTION
OF THE
ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS
HELD AT
SAN FRANCISCO, CAL.,

JULY 5, 6, AND 7, 1899.

EDITED BY

HARVEY W. WILEY,
SECRETARY OF THE ASSOCIATION.

WASHINGTON:
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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Division of Chemistry,
Washington, D. C., October 19, 1899.

Sir: I have the honor to transmit to you herewith the manuscript of the proceedings of the sixteenth annual meeting of the Association of Official Agricultural Chemists, with the request that it be published as Bulletin No. 57 of the Division of Chemistry.

H. W. Wiley,
Chief of the Division of Chemistry and Secretary of the Association of Official Agricultural Chemists.

Hon. James Wilson,
Secretary of Agriculture.

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PROCEEDINGS OF THE SIXTEENTH ANNUAL CONVENTION OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.

FIRST DAY'S PROCEEDINGS.

The sixteenth annual convention of the Association of Official Agricultural Chemists was held in San Francisco, Cal., beginning July 5, 1899. The meeting was called to order by the president, Mr. R. C. Kedzie, in the assembly hall of the Mills Building.

MEMBERS AND VISITORS PRESENT.

The following members and visitors were in attendance:

Allen, E. W., Office of Experiment Stations, Department of Agriculture, Washington, D. C.
Armsby, H. P., Agricultural Experiment Station, State College, Pa.
Bishop, R. Knight, Berkeley, Cal.
Blasdale, W. C., Agricultural Experiment Station, Berkeley, Cal.
Blouin, R. E., Agricultural Experiment Station, Audubon Park, La.
Burd, John S., Berkeley, Cal.
Buffum, B. C., Agricultural Experiment Station, Laramie, Wyo.
Chatfield, J. L., Gypsum, Colo.
Chilcott, E. C., Agricultural Experiment Station, Brookings, S. Dak.
Chesnut, V. K., Division of Botany, Department of Agriculture, Washington, D. C.
Cobb, N. A., Department of Agriculture, Sydney, New South Wales.
Colby, George E., Agricultural Experiment Station, Berkeley, Cal.
Cook, A. J., Claremont, Cal.
Curtis, Marvin, wine chemist with J. M. Curtis & Son.
Dyer, Hubert, Grand Junction, Colo.
Ellis, Frank F., Berkeley, Cal.
Frear, William, Agricultural Experiment Station, State College, Pa.
Goss, A., Agricultural Experiment Station, Mesilla Park, N. Mex.
Gould, Ralph A., San Francisco, Cal.
Hartwell, Burt L., Agricultural Experiment Station, Kingston, R. I.
Herff, B. von, German Kali Works, New York City.
Hills, J. L., Agricultural Experiment Station, Burlington, Vt.
Hite, B. H., Agricultural Experiment Station, Morgantown, W. Va.
Hutchinson, W. L., Agricultural Experiment Station, Agricultural College, Miss.
Jaffa, M. E., Agricultural Experiment Station, Berkeley, Cal.
Jenkins, E. H., Agricultural Experiment Station, New Haven, Conn.
Kedzie, R. C., Agricultural Experiment Station, Agricultural College, Mich.
Kilgore, B. W., Raleigh, N. C.
Lewers, Robert, Nevada State University, Reno, Nev.

Lloyd, E. R., Agricultural Experiment Station, Agricultural College, Miss.
McKellips, C. M., Agricultural Experiment Station, Corvallis, Oreg.
Miller, H. K., Agricultural Experiment Station, Lake City, Fla.
Muncy, V. E., Agricultural College of Kentucky, Lexington, Ky.
Myers, John A., 12 John street, New York City.
O'Brien, W. M., 1609 Oak street, San Francisco, Cal.
Patterson, Walter K., Agricultural Experiment Station, Lexington, Ky.
Redding, R. J., Agricultural Experiment Station, Experiment, Ga.
Rising, W. B., University of California, Berkeley, Cal.
Rosencrantz, A., San Francisco, Cal.
Rowley, B. N., 203 California street, San Francisco, Cal.
Runyan, E. G., Division of Chemistry, Department of Agriculture, Washington, D. C.
Scovell, M. A., Agricultural Experiment Station, Lexington, Ky.
Shaw, G. W., Agricultural Experiment Station, Corvallis, Oreg.
Smith, C. D., Agricultural Experiment Station, Agricultural College, Mich.
Snow, Frank J., Berkeley, Cal.
Stabler, H. P., Yuba City, Cal.
Stewart, J. H., Agricultural Experiment Station, Morgantown, W. Va.
Stockbridge, H. E., Agricultural Experiment Station, Lake City, Fla.
Thompkins, P. W., 123 California street, San Francisco, Cal.
Thompson, C. D., Corvallis, Oreg.
Tolman, L. M., Berkeley, Cal.
Traphagen, F. W., Agricultural Experiment Station, Bozeman, Mont.
Voorhees, Edward B., Agricultural Experiment Station, New Brunswick, N. J.
Wickson, E. J., Agricultural Experiment Station, Berkeley, Cal.
Wiley, H. W., Division of Chemistry, Department of Agriculture, Washington, D. C.
Williams, C. B., Agricultural Experiment Station, Raleigh, N. C.
Wilson, N. E., Agricultural Experiment Station, Reno, Nev.
Withers, W. A., Agricultural Experiment Station, Raleigh, N. C.
Withycombe, James, Corvallis, Oreg.
Woll, F. W., Agricultural Experiment Station, Madison, Wis.
Woods, Charles D., Agricultural Experiment Station, Orono, Me.
Wrampelmeier, T. J., Custom-house, San Francisco, Cal.

ORDER OF BUSINESS.

The executive committee reported the following order of business:

Reports of the referees in the following order:

First. Report on nitrogen.

Second. Report on potash.

Third. Report on phosphoric acid.

Fourth. Report on soils and ash.

Fifth. Report on foods and feed stuffs.

Sixth. Report on food adulteration.

Seventh. Report on dairy products.

Eighth. Report on sugars.

Ninth. Report on tannin.

Tenth. Report on nicotin.

Eleventh. Reports of special committees (abstract committee, food standards, uniform laws for fertilizer control, volumetric standards, rewriting methods of soil analysis), rewriting Bulletin 46.

PRESIDENT'S ADDRESS.[1]

Members of the Association of Official Agricultural Chemists: Continued custom finally assumes the function of law, the unwritten law of society, more pervasive than formal statutes, and controlling social relations and conditions because arising spontaneously in the affairs of daily life. This unwritten law of custom demands an address from the presiding officer of this association. In former years papers of great value have been presented as presidential addresses on a variety of topics related to our special lines of work, such as the progress and methods of fertilizer analysis and control; the analysis of foods and fodders, the detection and prevention of adulterations in commercial articles of this class; standards of purity of materials for foods and articles related thereto, etc.

Such papers, presented before such a body of men, can not fail of having a large influence in improving the conditions of living in the wide constituencies of States and communities here represented.

When we consider the progress made and the work already accomplished in your special lines of work, and the advanced condition of analytical methods you have attained, as compared with those of fifteen years ago, we find large encouragement. Nor is the value of this progress recognized in this country alone. The fact that the Chemical News republished bodily your special methods of analysis shows the standing in which your methods are held by chemists in Europe.

The new apparatus and appliances here brought into use, such as the Gooch crucible, the Babcock method for analysis of milk, the electrical air bath for drying precipitates and other materials without danger of overheating or need of constant watching, the electric lamp for continuous and safe distillation in the extraction of fat by ether—these and similar appliances will do much to mitigate the drudgery, yet increase the accuracy of chemical analysis for the future. The need for more rapid methods without impairment of accuracy is a thought often present to your minds. To this end any new apparatus or application of known forces to new uses will be welcome. Forty-seven years ago Liebig pointed out the great importance of cork, glass, platinum, and caoutchouc for the advancement of chemistry. We may now with equal emphasis speak of electricity in its many phases and uses as contributing to the success of the masterful science. But to show how shortsighted is the foresight even of the most acute minds it is only necessary to recall the fact that in the same delightful Familiar Letters on Chemistry, Liebig pointed out the folly of making sugar from beets and illuminating gas from coal; and this less than fifty years ago.

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[1] Delivered before a joint meeting of the Association of Official Agricultural Chemists and the Association of Agricultural Colleges and Experiment Stations, held in the Academy of Sciences.

New environments call out new duties. Up to this year all the annual conventions of this association have been held in the region lying east of the Mississippi River, and usually in the National Capital. The special agricultural requirements of the Eastern section, the limiting conditions of crop production by peculiarities of soil and climate, the favoring conditions for special crops and productions in certain districts, the diverse interests and contrasted capacities of different sections—these and similar topics have filled your minds, guided your pens, and penetrated your laboratories and experimental grounds for final solution.

In the East the soil is very literally the bottom fact of all agricultural processes, and it is to the soil we have given our chief attention; its chemical composition and physical properties, the quality and availability of the plant food in the soil, how to increase these and yet prevent their loss by the sapping and mining of subsoil drainage and percolation, by which soluble salts are finally swept into the all-devouring sea—such are some of the agricultural problems of the East.

But we have entered a new environment. Most of you have reached the Pacific slope by crossing the several ranges of the Rocky Mountains, and have not failed to mark the contrast in the flora of the eastern and western slopes of these "vast dividing walls of climate," and their influence upon the vast basins that lie between them. The principal chains of the American Continent lie along its western border, and their general trend is north and south. Think for a moment how different would be the climatic conditions if the trend of these mountain chains were east and west, as in the Old World. Picture to your minds the change in the climate of the great basins of the Rockies under such conditions. No mountain chains more emphatically claim Dove's telling phrase, "dividing walls of climate," than the Andean chain stretching from Alaska to Cape Horn.

Whatever the physical causes, we find ourselves in the midst of many sharp contrasts with the conditions prevailing in the East. A witty friend in southern California described the contrast between the East and West thus: "In the East you sell the soil and the climate goes with the land; here we sell the water and climate and throw in the land." "Si quaeris mundum novum, circumspice."

Here is a new world, and the changed conditions of agriculture challenge your attention. I need not stop to point them out. California is an open book, and he who runs may read.

In regard to new work for the coming year I have little to suggest. The work now in hand seems to be in good shape, and I have no criticism to offer. Following in the steps of my illustrious predecessors, my suggestions are mainly in the line of detecting and exposing frauds and adulterations connected with food materials. The subject of butter comes prominently into view in my section, not solely the old evil of oleo compounds, but the disguising and manipulating for purposes of sale of what was once butter, but has survived the period of its usefulness; putting the putrid stuff through some process and selling the same as prime butter. The Michigan legislature has just enacted a law to prevent the sale of this "process butter" unless it bears a printed certificate of its real character. How to identify in the courts this "process butter," so as to throw the protecting arm of the law over genuine prime butter, is a subject for your consideration. That carload lots of such "shoe-box butter" is thus treated to be offered for sale as creamery butter is well known. Some may say that any treatment by which the rancid stuff may put on an appearance of respectability should be encouraged, and reform even in butter should be approved. Lord Brougham said "change is not reform." I quote the old maxim "Let every (butter) tub stand on its own bottom."

In a similar class may be placed such materials as "Lactobutu," to convert 10 pounds of rancid butter and 5 pounds of milk into 15 pounds of good butter, the material and information for $5. Some may say that a man who does not know that 5 pounds of milk can not be converted into 5 pounds of butter by any chemicals or manipulation ought to invest $5 to buy wisdom much needed. But in olden times, of ten virgins five were wise and five otherwise, and if observation is not misleading, the proportion of the first class in the human family has not largely increased in nineteen centuries.

Other items in the list of doubtful honesty are so-called stock foods, one especially represented as greatly excelling oil meal in value. These should generally be classed simply as condiments or condition powders so familiar to stockmen.

Wheat flour is so intimately related to the staff of life, and American flour is of such excellent quality and high reputation, both at home and abroad, that any adulteration of the material or smirching its reputation should call forth an indignant protest. The material is not only so good in quality but so abundant in our country that there should be no excuse for adulterating it. But the process was begun in a neighboring State and it spread so rapidly as to threaten to drive out honest milling from our land. The most common form of adulteration ("blending" as it was euphoniously called) was by mixing with wheat flour a quantity of white corn meal, corn starch ("flourine") or other products of Indian corn. The profits from incorporating the products of the cheaper grain with wheat flour were so large that the adulterated flour could be sold at a price much below pure wheat flour, yet leaving so large a margin of profit that genuine wheat flour was being driven out of its legitimate market. A miller at the head of a large milling concern in another State told the late W. A. Coombs, of Coldwater, Mich., that "by blending corn products with my wheat flour I make a cash profit of $600 a day, and why should I not do it?" A man who will ask that question will do it.

The Michigan millers were almost in despair. They could not sell flour in the Southern States except at a loss, and were being driven out of the Eastern States. There was even danger that such adulterated flour would be sent abroad, and when detected there the European markets would be closed against American flours as a class. The millers urged Congress to pass a law to prevent such mixed flours from being sold as wheat flour, and the Tawney bill was introduced to compel the marking of such flours as mixtures, and thus distinguishing them from genuine flour. But a powerful corn-fed lobby prevented such legislation till the Spanish war was upon us and the sinews of war must be obtained from every available source, when a small license fee was demanded and a small tax imposed, requiring a stamp upon every package of the mixed flour. When such a mark of Cain is placed upon a food material it becomes a fugitive and vagabond on the earth.

Another adulterant for wheat flour requires only a brief notice, for it can only be short-lived. This material is prepared and shipped in some quantity from Greensboro, N. C., under the name of Mineraline. It is nothing but ground rock of the feldspathic class, and its food value nil, yet the party making this stuff seems to find quite a market for it. A friend in Greensboro one year ago wrote me that this party held an order for 150 tons of Mineraline to be shipped to Tennessee to mix with flour, and was shipping car lots to northeastern cities for the same purpose.

In olden times the question arose "If a son ask his father for bread, will he give him a stone?" This question seems to have found an affirmative answer in North Carolina.

APPOINTMENT OF COMMITTEES.

The president appointed the following committee on recommendations of referees: Messrs. Woods, Scovell, Jenkins, Hutchinson, and Shaw.

Messrs. Frear, Woll, and Colby were appointed a committee on nominations.

Mr. Wiley. The reporters, or referees, have had very little time in which to prepare their material, and therefore the secretary of the association suggested that in the absence of ample data each one should give a short résumé of the evolution of the subject assigned him from the beginning of the association to the present time, so that we could have a historical account of what had really been accomplished in the way of codifying, unifying, and perfecting the methods employed in the investigation.

With the same object in view I have prepared a full history of the meetings before the present association was organized. I did this because the earlier reports are not available. The library of the Department of Agriculture itself does not possess them, and in order to prepare the data for this paper I was compelled to resort to the members who composed these earlier meetings, to whom I addressed circular letters. From many of them I received replies. I propose to incorporate in the report of this meeting the minutes of the meetings held in 1880 in Washington, and in Boston in the same year, and of the meetings held in Cincinnati in 1881 and in Atlanta in 1884. Thus the members of the present association will be able to have a complete record, in conjunction with the bulletins issued, of the progress this association has made during the period of nineteen years since the attempt was made to unify methods of research in agricultural chemistry.

Mr. FREAR. In view of the method of discussion suggested to the several referees by the association, and of the conditions of this meeting, and in view of the fact that the secretary himself has prepared a résumé of the history of the work of the association in general, it occurs to me that it might be desirable to have this last-named paper read first, as a proper introduction of the discussion. I would therefore move that the secretary of the association be requested to read this historical sketch to open the work.

Mr. WILEY. Mr. President and Gentlemen: I will not read the whole of this paper, because it will be found in full in the report of the proceedings. The title of this paper is "Historical Sketch of the Association of Official Agricultural Chemists," and, preliminarily, I will say that I have prepared a list of those present at the Atlanta meeting in 1884, which was the precursor of the organization that is meeting here to-day. As perhaps it will be interesting I will read the names of those present at the Atlanta meeting:

Judge J. T. Henderson, Prof. H. W. Wiley, Prof. N. W. Lord, Dr. Charles W. Dabney, jr., Prof. William A. Noyes, Dr. Charles U. Shepard, jr., Dr. J. W. Gascoyne, Dr. Allard Memminger, Mr. Philip E. Chazal, Dr. E. H. Jenkins, Prof. S. W. Johnson, Prof. H. C. White, Dr. N. P. Pratt, Mr. G. W. Benson, Mr. N. A. Pratt, Prof. John A. Myers, Prof. J. A. Burns, Mr. L. H. Jones, jr., Mr. C. L. Allen, Mr. G. W. Davison, Prof. W. C. Stubbs, Dr. Arthur T. Neale, Mr. P. T. Pendleton, Mr. C. B. F. Lowe, Mr. Leroy Broun, jr., Mr. C. M. Strahan, Mr. A. F. Crowell, Mr. C. V. Petraeus, Mr. Theo. Schumann, Mr. P. J. Schumann.

Many of these names you will recognize as being those of men who have been most active in the work of the association since the Atlanta meeting.

The following is a list, arranged alphabetically, of official agricultural chemists, and others associated with them who have attended the several meetings since the organization of the association:

List of Members who have attended the Meetings of the Association of Official Agricultural Chemists, and the Numbers of the Meetings attended by Each.

Adriance, Duncan, 8.
Alexander, J. P., 12.
Allen, E. W., 7, 8, 9, 11, 13, 14, 15.
Allen, W. M., 13.
Alvord, Henry E., 7, 15.
Anderson, Cyrus N., 14.
Anderson, James T., 6, 7, 8, 9, 11, 12, 14.
Andrews, W. H., 14.
Armsby, H. P., 9, 13.
Atwater, B. M., 14.
Atwater, W. O., 6, 7, 10, 15.
Babcock, S. M., 4, 8, 9, 10.
Bartlett, J. M., 8, 11, 12, 14, 15.
Battle, H. B., 6, 7, 8, 13.
Beal, W. H., 9, 11, 12, 13, 14, 15.
Benjamin, Marcus, 12.
Bigelow, W. D., 9, 10, 11, 12, 13, 14, 15.
Black, S. E., 9.
Blair, A. W., 14.
Blouin, R. E., 10.
Bolton, H. Carrington, 14.
Bomberger, F. B., 12, 13.
Bond, Charles E., 4.
Bowman, Walker, 6, 7.
Broadbent, F. V., 2, 3, 4.
Bromwell, William, 11.
Brown, W. G., 12.
Bryant, A. P., 14.
Buckley, S. S., 13.
Burney, W. B., 6, 7.
Caldwell, G. C., 4, 6, 7, 8, 13.
Cameron, F. K., 14.
Cameron, George W., 14.
Carman, J. S., 11.
Carman, J. Y., 9.
Carpenter, F. B., 7, 8, 11, 13, 14, 15.
Carr, Oma, 11, 12, 13, 14, 15.
Cathcart, Charles S., 8, 9.
Chace, E., 9.
Chazal, Philip E., 1, 2, 3, 4, 5, 10.
Chesnut, V. K., 12, 13.
Chute, H. D., 11.
Clark, Reed Paige, 14.
Clarke, F. W., 2, 6, 8, 9, 13.
Coates, Charles B., jr., 14, 15.
Cochran, C. B., 10.
Collingwood, Charles B., 8, 10.
Cooke, W. W., 3, 7, 8.
Craighill, G. P., 14, 15.
Crampton, C. A., 2, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14.
Crawley, J. T., 8.
Croxton, H. E., 12.
Curtis, H. E., 10, 13.
Cutter, W. P., 11, 12, 13, 14.
Dabney, Charles W., jr., 1, 2, 5, 8.
Dancy, F. B., 7.
Davidson, R. J., 8, 9, 11, 12, 13, 14.
Davis, I. T., 8.
Dickeson, William E., 14.
Doremus, C. A., 10.
Dorset, Marion, 12.
Dugan, John, 4, 5, 9, 12, 13.
Eaton, C. N., 10.
Edson, Hubert, 5, 7, 8.
Ellett, W. B., 14.
Elliott, J. C., 8
Englehardt, F. E., 6.
Ewell, E. E., 9, 10, 12, 13, 14, 15.
Fake, N. J., 4, 5.
Farrington, E. H., 4, 5, 7, 8, 10, 11.
Fellows, G. S., 3, 4, 6, 8, 9.
Fernandez-Cavada, Fernando, 14.
Finney, F. I., 11.
Fraps, G. S., 13.
Frear, William, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15.
Fries, J. A., 10, 12.
Fristoe, E. T., 8.
Fuelling, John L., 8, 11.
Fulmer, Elton, 14.
Gaines, R. H., 1, 5, 6, 7, 8, 10, 12, 13, 14, 15.
Gardner, F. D., 12.
Gascoyne, W. J., 2, 3, 4, 5, 6, 7, 8, 11, 15.
de Ghequier, C., 1, 2, 3, 4, 7.
Gibson, Charles B., 7.
Gladding, Thomas S., 2.
Goss, Arthur, 12, 13.
Green, Arthur L., 4.
Grindley, H. S., 14.
Hand, W. F., 14.

Hardee, R. E., 9.
Hardin, M. B., 9.
Harper, D. N., 8.
Harrington, H. H., 6, 8, 9.
Harris, A. W., 7, 8, 9.
Hartwell, B. L., 10 15.
Haywood, J. K., 14, 15.
Heavener, J. G., 12.
v. Herff, Rudolf, 7, 8, 9, 11, 12, 13.
Hills, J. L., 13, 14, 15.
Hiltner, R. S., 15.
Hird, J. D., 6, 13, 14.
Hite, B. H., 12, 13, 14, 15.
Holland, E. B., 15.
Holter, George L., 6.
Holton, Fred A., 4, 5, 9.
Horton, H. E., 7.
Huston, H. A., 7, 8, 9, 10, 11, 12, 13, 14, 15.
Hutchinson, P. L., 9.
Hutchinson, W. L., 5, 6, 9, 12.
Jaffa, M. E., 15.
Jenkins, E. H., 1, 2, 3, 4, 6, 8.
Jenter, C. G., 14.
Johnson, D. D., 8.
Johnson, S. W., 13.
Jones, Charles H., 14, 15.
Jordan, W. H., 8.
Kebler, L. F., 10.
Kedzie, F. S., 11.
Kedzie, R. C., 6, 7, 8, 9, 10, 12, 15.
Kepich, A., 11.
Kerr, G. A., 11, 15.
Kilgore, B.W., 6, 8, 9, 10, 11, 12, 13, 14, 15.
Knorr, A. E., 2, 3, 4, 5, 7, 8, 9.
Knox, Roy, 14.
Krug, W. H., 8, 9, 11, 12, 14, 15.
Krumbharr, Chas. Conrad, 14.
Langfeldt, Felix, 4.
Langworthy, C. F., 13, 14, 15.
Laughlin, J. R., 13, 14, 15.
Lehmann, A., 1, 3, 9.
Lehmann, G. W., 14.
Lindsey, J. B., 10, 11, 12, 13, 14.
Lord, N. W., 4, 8, 10.
Lupton, N. T., 3, 4, 6, 7, 8, 9.
McAdie, A. G., 8.
McCarty, R. Lee, 15.
McBryde, J. B., 6, 7.
McDonnell, C. C., 12.
McDonnell, H. B., 6, 7, 8, 9, 10, 11, 12, 13, 14, 15.
McDonnell, M. E., 11, 12.
McDowell, M. S., 12.
McElroy, K. P., 8, 9, 10, 11, 12.
McMurtrie, William, 3, 4.
Macfarlane, Thomas, 4.
Manns, A. G., 12.
Maxwell, Walter, 8.
Meng, Jas. S., 15.
Merrill, L. H., 12, 13.
Mitchell, A. S., 12.
Mitchell, G. A., 10.
Mitchell, W. L., 15.
Moore, C. C., 12, 13, 14, 15.
Morse, Fred W., 6, 8, 11, 12, 15.
Moses, W. E., 2, 3, 4.
Munroe, C. E., 14.
Myers, John A., 1, 3, 4, 5, 6, 7, 8, 12, 13, 15.
Nicholson, H. H., 6, 7, 8.
Nolan, W. P., 11.
North, J., 14.
Ogden, A. W., 8.
Palmer, T. Chadley, 15.
Parsons, Charles L., 7, 9, 10.
Patrick, George E., 8, 13, 14.
Patterson, H. J., 5, 6, 7, 8, 9, 11, 12, 13, 14, 15.
Patterson, L. G., 7, 8, 12.
Payne, George F., 8, 9, 10, 11, 12.
Peacock, S., 11, 12, 13, 14.
Peebles, A. B., 15.
Penny, C. L., 7, 8, 9, 12, 13, 14.
Perkins, George E., 14.
Perkins, W. R., 10, 11, 13.
Persons, A. A., 12, 14.
Peter, A. M., 9, 11, 12.
Price, W. B., 2.
Quick, W. J., 13.
Rawls, W. A., 10, 11, 12.
Richards, Edgar, 2, 3, 4, 5, 6, 7.
Richardson, Clifford, 1, 2, 3, 4, 5, 6, 7.
Rising, W. B., 4, 10.
Robinson, Norman, 6, 7, 8, 9.
Robinson, S. A., 8.
de Roode, Rudolf, 8, 9, 10, 11.
Rosell, C. A. O., 12.
Ross, B. B., 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15.
Runyan, E. G., 11, 12, 13, 14, 15.
Sanborn, T. F., 11, 12.
Saunders, W. M., 5.
Schulte, J. I., 15.
Schumann, Dr., 1.
de Schweinitz, E. A., 4, 5, 7, 8, 9, 10, 11, 13, 14, 15.
Scovell, M. A., 3, 4, 5, 6, 7, 8, 9, 10, 13, 14, 15.
Seal, Alfred N., 15.

Sederholm, E., 10.
Sharpless, S. P., 10.
Shepard, Jas. H., 8.
Sherman, H. C., 10, 11, 12.
Shiver, F. S., 7, 9.
Shutt, Frank T., 4, 10, 13.
Shuttleworth, A., 11.
Slosson, E. E., 10.
Skinner, W., 12, 13, 14, 15.
Smith, H. M., 10.
Snyder, Harry, 15.
Spencer, G. L., 9, 11, 14.
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Stewart, J. H., 15.
Stokes, H. N., 15.
Strahan, C. Morton, 6.
Street, J. P., 7, 8, 9, 10, 11, 12, 13, 14, 15.
Stubbs, William C., 2, 3, 4, 5, 7, 8, 10, 12.
Sutton, D. C., 8
Sweetser, W. S., 14.
Tassin, Wirt, 11, 12.
Teller, George L., 8, 10, 13.
Terne, Bruno, 6, 7, 8, 9, 11, 12.
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Trescot, T. C., 3, 7, 10, 12, 13, 14, 15.
Trubek, M., 10.
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Van Slyke, L. L., 7, 8, 9, 10, 11, 12, 13, 14, 15.
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Voorhees, E. B., 5, 6, 7, 8, 9, 11.
Voorhees, Louis A., 8, 9, 10, 11, 15.
Wahl, R., 10.
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Waite, C. E., 4.
Warder, Robert B., 4, 6.
Warrington, R., 8.
Watson, T., 11.
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Welty, Harry T., 14.
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Wiley, H. W., 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15.
Williams, C. B., 13, 14, 15.
Williams, William J., 7, 8.
Wilkinson, L. W., 8.
Winton, A. L., 8, 9, 10, 11, 12, 13, 14, 15.
Withers, W. A., 8.
Wolff, Frank A., jr., 12.
Woll, F. W., 10, 11, 15.
Woods, Charles D., 7, 8, 9, 12, 15.
Yeates, W. S., 9.
Yocum, J. H., 11, 13, 14, 15.

HISTORICAL SKETCH OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.

By H. W. Wiley.

The condition of agricultural chemical work in the United States in 1880 was a peculiar one. The few chemists who were engaged in agricultural research were acting in complete independence of each other in regard to methods of investigation and of research. Some of them were using the methods employed by German chemists, while others followed the instruction given by the French or English agricultural chemists. There was no unity of interest in the profession nor any common system of work. The condition of analytical work may be truly described as chaotic. The result of such condition is easily imagined. There was no standard of comparison or reference. Buyers and sellers were continually wrangling over analyses, which, made by different men following different methods, did not agree.

The sellers' chemists uniformly obtained higher results than the buyers', and thus the door to litigation was constantly open.

Strange as it may seem, the first steps toward correcting this pitiable condition did not come from the Department of Agriculture at

Washington, but from the department of agriculture of one of the States. It was through the Hon. J. T. Henderson, commissioner of agriculture of Georgia, and at the instigation of Mr. H. J. Redding, now director of the Georgia station, that the first step toward uniformity of action among agricultural chemists of the United States was taken.

The report of this initial meeting is of such interest as to warrant its reproduction in full in the proceedings of this association:

Convention of Agricultural Commissioners and Chemists at Washington, D. C.[1]

The following circulars will explain in brief the object of the convention:

DEPARTMENT OF AGRICULTURE,
Atlanta, Ga., May 20, 1880.

——— ———,
———, ———.

DEAR SIR: The experience of the last fertilizer season has suggested to my mind the importance of securing such uniformity of method in determining by chemical analysis the percentage of valuable ingredients in commercial fertilizers as will give more uniform and hence more satisfactory results. This is especially desirable in determining reverted phosphoric acid.

With a view to accomplishing so desirable an object, as well as others which may be deemed proper, I have the honor to suggest the calling of a convention of the several commissioners of agriculture, representatives from the State boards of agriculture, State chemists, and professors of chemistry in State universities and State agricultural colleges, in those States using large amounts of commercial fertilizers, to meet at some convenient point early in the month of July next.

I would be glad to have your views on the subject; and if favorable to the suggestion, please nominate some gentleman who, by general assent, may be informally authorized to fix the time and place of such convention and issue the necessary notices.

You are also requested to give me the names and post-offices of gentlemen in your State, holding either of the positions above indicated, which do not appear in the list below, that copies of this circular may be sent to them.

An early reply is desirable.

Very respectfully,
J. T. HENDERSON,
Commissioner of Agriculture.

DEPARTMENT OF AGRICULTURE,
Atlanta, Ga., July 1, 1880.

——— ———,
———, ———.

DEAR SIR: I am gratified to announce that the recent circular which I had the honor to issue, suggesting the calling of a convention for the purpose of adopting a uniform system for the analysis of commercial fertilizers, has met with favorable responses from a large majority of the gentlemen to whom it was sent. A like majority has imposed upon me the duty of fixing the time and place of said convention and issuing the necessary notices for the same. After correspondence with others, and due consideration of the interests involved, I have decided upon Wednesday, the 28th of July, as the time and Washington, D. C., as the place for the assembling of the proposed convention. You are accordingly respectfully and earnestly invited to be present and participate in the convention.

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[1] Proceedings of the convention of agricultural chemists called for the purpose of adopting a uniform method for the analysis of commercial fertilizers. Published by James P. Harrison & Co., Atlanta, Ga., 1880.

Every reasonable facility for the deliberations of the convention will be afforded by Hon. William G. LeDuc, Commissioner of Agriculture, who is in hearty sympathy with the object sought to be accomplished. I have appended hereto a list of the names of gentlemen to whom this circular will be sent.

Trusting you will find it convenient to attend and give the convention the benefit of your experience, and requesting that you will at once inform me by letter whether you will attend, I am, respectfully,

J. T. HENDERSON,
Commissioner of Agriculture.

PROCEEDINGS.

FIRST MEETING.

LIBRARY HALL, *July 28, 1880.*

In response to these circulars there assembled in one of the spacious halls of the Department of Agriculture, which was kindly set apart by the Commissioner of Agriculture, the following gentlemen:

Prof. R. M. Ballentine, United States Department of Agriculture.
Dr. C. Elton Buck, manufacturing chemist, Wilmington, Del.
Hon. A. P. Butler, commissioner of agriculture, State of South Carolina.
Dr. Peter Collier, Chemist of the United States Department of Agriculture.
Dr. M. G. Ellzey, professor Virginia Agricultural and Mechanical College.
Dr. C. A. Goessmann, Agricultural College, Amherst, Mass.
Prof. W. M. Habirshaw, analytical chemist, New York City.
Hon. J. T. Henderson, commissioner of agriculture, State of Georgia.
Dr. E. H. Jenkins, Connecticut Agricultural Experiment Station.
Dr. A. R. Ledoux, North Carolina Agricultural Experiment Station.
Dr. G. A. Liebig, analytical and manufacturing chemist, Baltimore, Md.
Prof. Arthur T. Neale, New Jersey State Experiment Station.
Dr. N. A. Pratt, State chemist, Georgia.
Prof. R. W. L. Rasin, manufacturing chemist, Baltimore, Md.
Dr. Charles U. Shepard, jr., chemist, State of South Carolina.
Dr. W. Simon, analytical chemist, Baltimore, Md.
Dr. C. C. Wellington, United States Department of Agriculture.
Dr. H. C. White, professor, University of Georgia.
Dr. P. B. Wilson, analytical chemist, Baltimore, Md.
Dr. Theo. R. Wolf, professor and State chemist, Delaware.

The convention was called to order at 3.30 p. m. by Dr. C. U. Shepard, jr., who nominated Hon. J. T. Henderson for president of the convention, reminding the gentlemen that it was owing to Judge Henderson's earnest efforts that they were brought together. Judge Henderson, being called to the chair, after thanking the convention for the honor done him, stated the object of the meeting as substantially set forth in the circulars above given.

Dr. A. R. Ledoux was then elected secretary of the meeting.

Dr. M. G. Ellzey addressed the convention, saying that he heartily indorsed the effort which Judge Henderson was making to secure uniformity in the analysis of commercial fertilizers. He recognized the need of some general understanding in the matter, and hoped that the discussions would take no limited range, but deal with more than one of the questions which have been the cause of difficulty between producers and farmers throughout the country.

Letters were read from Prof. S. W. Johnson, of New Haven, and others, heartily indorsing the object of the meeting and thanking Judge Henderson for his action in calling the same.

On motion of Dr. Ellzey the chair appointed a committee on a programme or order of business, to recommend to the convention what topics should be discussed. The following committee was appointed: Drs. Goessmann, Buck, and White. The committee recommended the following programme. The report was received and adopted.

PROGRAMME.

1. Preparation of the roll of the convention, and decision of the rights of parties present to participate in the discussion of various topics, and to vote upon the final judgment of the same.
2. Discussion of the method of estimating soluble phosphoric acid.
3. Discussion of method of estimating "reverted" phosphoric acid
4. Estimation of insoluble phosphoric acid.
5. Estimation of nitrogen.
6. Estimation of potash.

The committee consider the above the main topics which should receive the consideration of the convention. Other points proper for discussion, should time allow, are, perhaps, as follows:

7. Method of arriving at commercial valuations.
8. Agricultural and commercial valuation of "reverted" phosphoric acid.

In accordance with section 1 of the order of business, the secretary was ordered to make out and read the roll of the convention, together with the occupations and professions of the gentlemen present.

Dr. White moved that only those who are practicing, analytical chemists be considered entitled to vote on the final judgment of the meeting.

Dr. Ellzey opposed the motion, saying he would very much regret to see the convention limited in that way.

The secretary called attention to the fact that all the gentlemen present but three were practicing, analytical chemists, and entitled to vote under the above resolution.

After some further discussion, the resolution was adopted.

The convention then, on motion, took up the discussion of the second section of the programme—determination of soluble phosphoric acid.

Drs. Goessmann and Ellzey gave their opinions as to the extent and direction which the discussion should have.

It was moved by Dr. Ledoux that a committee of three be appointed by the chair to propose to the convention a method for the determination of soluble phosphoric acid.

Dr. Collier moved to amend by substituting "five" for "three."

Dr. Shepard moved, as a substitute, that the entire question of the determination of phosphoric acid in all its forms be referred to a committee of five.

After discussion, the following resolution was adopted:

Resolved, That a committee of five be appointed by the chair to consider sections 2, 3, and 4 of the order of business and report thereon.

The following gentlemen were appointed by the chair: Drs. Shepard, Goessmann, Liebig, Jenkins, and Wolf.

On motion of Dr. White, it was ordered that a committee of five be appointed to take into consideration sections 5 and 6 of the order of business and report thereon. Drs. Habirshaw, Wilson, Neale, Buck, and Pratt were appointed.

On motion, section 5 of the order of business was amended so as to include nitrates.

The convention then took a recess until 6.30 p. m., to allow the committee time to report.

The convention came to order at 7 p. m. The committee on sections 2, 3, and 4 (phosphoric acid) offered the following report, which, after reading and being discussed by several gentlemen at considerable length, was received and adopted.

REPORT.

It is recommended by your committee to whom was referred the selection of a method for the determination of phosphoric acid in commercial manures—

That this convention shall agree to adopt, provisionally, the methods recommended by Fresenius, Neubauer, and Luck in their article "On the best methods for the analysis of artificial manures."

Zeitschrift für analytische Chemie, X, p. 133, with the following suggestions:

1. That the flask containing the residue (after the extraction of the soluble phosphoric acid) and the solution of citrate be introduced into a cold water bath, whose temperature shall be rapidly raised to 40° C., and there maintained for one-half hour, the flask being shaken every five minutes.
2. That the determination of the "reduced" phosphoric acid be indirect.
3. That all the determinations be gravimetric.
4. That a committee of two, to be named by the chairman, be appointed to prepare, on the above basis, a detailed method for the analysis of commercial manures, and to distribute the same among the members of this convention and others interested by this action.

Charles U. Shepard, Jr.,
Chairman of Committee.

The following report of the committee on sections 5 and 6 of the programme (nitrogen and potash) was received and adopted:

REPORT.

Estimation of nitrogen and potash in commercial manures.

I. Determination of nitrogen (total):

(*a*) When the three forms of nitrogen are present (nitrates, ammonia salts, and organic nitrogen), a combustion with oxide of copper or plumbic chromate.

(*b*) When nitrates are not present, a combustion with soda-lime and the resulting ammonia estimated with platinum chloride or titrated with a normal solution (alkali).

II. Determination of nitric acid when in presence of ammonia salts and organic nitrogen:

(*a*) Nitrates and ammonia salts are brought into water solution and the nitric acid is converted into ammonia by Harcourt and Siewert's process.—(Zeitschrift für analytische Chemie, 1871, 334; Jour. Chem. Soc., 1862, 381; An. Chem. und Phar., 125, 293; Sutton Volumetric Analysis, London, 3d ed., 1876, 102 et seq.)

(*b*) Nitrates are brought into water solution and the nitric acid estimated by Schlossing's method, modified by Schultz, viz, distillation in presence of ferrous chloride with excess of hydrochloric acid. The NO gas is collected and measured.—(Schlossing's Original Paper, Annal de Chim., 3 ser., tom. 40, 479; Jour. für Pract. Chemi., 62–142.)

III. Determination of nitrogen existing as ammonia salts:

The solution in water is distilled with magnesium oxide and the ammonia estimated either by the platinum method or by titration with normal acid.

IV. Determination of the nitrogen when existing in a substance, in separate forms, as nitrates, ammonia salts, and organic nitrogen:

(*a*) Estimation of total nitrogen by I *a*.
(*b*) Estimation of total nitric acid by II *b* or II *a*.
(*c*) Estimation of total ammonia salts, III.
(*d*) Estimation of total organic nitrogen by difference.

V. Estimation of potash:

Only salts of potash soluble in water are considered in this report (except when the potash occurs in seeds, in which case previous calcination is recommended).

(*a*) Solution in water, removal of sulphates, phosphates, and magnesia by barium hydrate, clearing with oxalate or carb. ammonia and precipitating with platinum chloride.

W. M. Habirshaw, *Chairman.*

On motion, it was ordered that the two reports be referred to a committee of two, who should copy them, giving details of the methods to be employed, and send to each member of the convention a copy of the same.

On motion, a letter of Dr. S. A. Goodale was considered and referred to the above committee.

After remarks and discussion of the above reports, it was suggested that, since so many agricultural chemists were present, it would be desirable to effect a permanent organization, to meet from time to time and discuss topics of interest to the profession. Dr. Goessmann offered the following resolution:

Resolved, That this convention form a section in the subdivision of chemistry in the American Association for the Advancement of Science, and that their next meeting be held in Boston during the regular meeting of the aforesaid association.

On motion, Dr. Goessmann's resolution was adopted. Dr. Shepard thought it would be well to refer the matter to a committee to draw up a plan for a permanent organization, and offered a resolution to that effect. Drs. Goessmann and Wilson were appointed to arrange for a permanent organization of the convention, as called for in the resolution of Dr. Shepard.

On motion, section 7 of the order of business was taken up by the convention. A long discussion followed, which was participated in by Drs. Elzey, Collier, Jenkins, and others. No final action was taken upon this section, but it will be further considered at the forthcoming meeting of the convention in Boston. The committee on permanent organization made the following report, which was received and adopted:

REPORT.

The committee on permanent organization propose that Dr. Goessmann be made chairman until the next annual meeting in connection with the American Association for the Advancement of Science, and that Dr. Ledoux be appointed secretary.

P. B. Wilson, *Chairman.*

On motion, the thanks of the convention were tendered Judge Henderson for his courtesy and skill as presiding officer.

On motion, the following resolution was unanimously adopted:

Resolved, That the thanks of this convention are hereby tendered to General LeDuc, Commissioner of Agriculture, for his courtesy; and also to Professor Collier, the Chemist of the Department, for his kindness and attention.

On motion, the convention adjourned.

The committee who were appointed to write out the details of the methods of determination of phosphoric acid have forwarded the secretary the following

REPORT.

Method for the determination of phosphoric acid in commercial manures.

1. Preparation of the sample. It is not to be ground, but may be broken up by hand, and should be thoroughly mixed as rapidly as possible and transferred to a tightly stopped bottle.

2. Determination of the soluble and "undecomposed" phosphoric acid.

(*a*) Two grams of the material, transferred to a suitable vessel, are rubbed up with a small quantity of cold water (carefully avoiding any pulverization), transferred to a filter and there washed with cold water, which is added at first in small successive portions until the washings no longer react acid.

Soluble phosphoric acid is determined in the filtrate.

(*b*) The filter, containing the "reverted" and "undecomposed" phosphates, is carefully spread on a glass plate. With the aid of a wash bottle containing 100 cubic centimeters of a perfectly neutral solution of ammonium citrate (sp. gr. 1.09) the residue is washed into a lipped porcelain mortar. The coarser portions are allowed to settle, and the fluid, with the suspended particles, is poured into a small flask. The residue remaining in the mortar is rubbed to a very fine paste and brought with the remainder of the ammonium citrate into the flask, which is then corked.

This flask is put into a cold water bath, the temperature is rapidly raised to 40° C., and there maintained for one-half hour, care being taken to shake the flask every five minutes. It is then removed and the contents immediately filtered.

The residue is washed two or three times with a mixture of equal parts of water and ammonium citrate solution, and used for the determination of "undecomposed" phosphoric acid.

3. The total phosphoric acid is determined in a separate portion of 1 to 2 grams.

The other details are as given by Fresenius, Neubauer, and Luck (loc. cit.).

The committee have read with great interest the communication of Dr. S. L. Goodale, referred to them, and beg leave to return it to the secretary for presentation at a future meeting of the convention, when its contents may receive the attention they deserve.

Charles U. Shepard, Jr.,
Ewd. H. Jenkins,
Committee.

The above is respectfully submitted.

A. R. Ledoux, *Secretary.*

J. T. Henderson, *Chairman.*

In harmony with the vote of the convention the association assembled again in Boston on the 27th of August, 1880. This meeting is also worthy of perpetuation in the printed proceedings of this association, and so the minutes are inserted in full:

Proceedings of the Second Meeting of the Convention of Agricultural Chemists, held at Boston, Mass., August 27, 1880.[1]

The meeting took place in the library of the Society of Natural History, which was kindly set apart for the use of the convention. The convention came to order at half past 2. Dr. C. A. Goessmann occupied the chair. About 25 gentlemen were present.

The minutes of the meeting in Washington were read and approved.

Drs. Caldwell, Kerr, White, Atwater, Sharples, and Ledoux took part in discussions as to the advantage of permanent organization, the choosing of a name, etc. A general opinion prevailed that for the present at least it would be sufficient to form a subsection or subdivision of a subsection of the American Association for the Advancement of Science. It was suggested by Dr. Clarke, of Cincinnati, that we unite with botanists, practical agriculturists, and others to form a subsection of agricultural scientists, instead of simply organizing as agricultural chemists. This proposition did not meet with general approval. It was pointed out that efforts were already being made to organize a club of scientific agriculturists; that in fact such an organization had been effected the preceding day. It was also stated that such an organization need not conflict in any way with one devoted especially to chemical work relating to and connected with agriculture.

The minutes of the Washington meeting having been approved, the chairman stated that the next business in order was the reading and adoption of the report of the committee of two, to whom was referred by the convention (for elaboration and amplification) the reports of the committees on the determination of phosphoric acid, ammonia, and potash, adopted by the convention in Washington. The reading of the report brought out considerable discussion as to the methods which were recommended, in which Drs. Atwater, Caldwell, and others took part. The reports were adopted provisionally for one year.

Dr. Clarke stated to the convention that a movement had been inaugurated to have a section of chemistry in the American Association for the Advancement of Science, and suggested that this very desirable object could possibly be attained more easily by showing the association that not only were the chemists ready to form such a section but were even ready to form at least one subsection—of agricultural chemistry—whenever the way was open. Dr. White offered the following resolution:

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[1] Published in the proceedings of the third meeting of the convention of agricultural chemists held at Cincinnati, Ohio, August 18, 1881. Jas. H. Folan, printer, 79 and 81 William street, New York. 1881.

Resolved, That a committee of three be appointed by the chair to take such steps as may be necessary for securing the formation of a permanent chemical section in the American Association for the Advancement of Science, and the establishment of a subsection of agricultural chemistry in such permanent section, should it be formed.

The chairman appointed as committee Drs. White, Caldwell, and Ledoux.

An extended discussion was then had concerning the best means for securing the cooperation and adoption of the best methods of analysis by not only the chemists in the convention, but all those whose duty it was to make analysis of commercial fertilizers throughout the country. Dr. Sharples thought methods indorsed by the convention would be considered binding by other chemists throughout the country, but considered that experiments should be made fully to establish the fitness of the methods proposed at the Washington meeting.

Dr. Ledoux said that while he thought we would still be more or less dependent for some years upon the thought and experiments of the chemists of the Old World, the time had come when we should make more experiments for ourselves, even if we do nothing more than confirm the methods and results of Fresenius, Neubauer, Luck, and others. He suggested that many chemists would be glad to institute any experiments needed to attain the end desired, and that the time had come to collate and examine the various methods of determining phosphoric acid, ammonia, and potash, which have from time to time been published by our agricultural chemists. He considered that the collection and examination of the methods published and their adoption and reduction to one system, after careful experimental research, would give to the final action of this convention an authority which would be recognized by every one. Several gentlemen expressed their willingness to make any experiments which might be desired, and to do their share in perfecting a scheme of analysis. The following resolution was unanimously adopted:

Resolved, That a committee of five be appointed by the chair to secure the cooperation and experimental research of agricultural chemists, to collect and examine the various published methods of fertilizer analysis, and to make a report at the next meeting of this convention; and that we individually pledge ourselves to conduct, for this committee, any experiments or tests which they may desire.

The chair appointed Drs. S. W. Johnson, C. U. Shepard, jr., Peter Collier, W. O. Atwater, and G. C. Caldwell.

It was moved by Dr. Collier that when we adjourn we adjourn to meet at the same time and place, in 1881, as the American Association for the Advancement of Science. Adopted.

It was moved and seconded that the present chairman and secretary hold over until the next meeting. Adopted.

On motion, the convention adjourned.

A. R. Ledoux, *Secretary*.

✓ The third meeting of the agricultural chemists was held in Cincinnati August 18, 1881. In connection with the meetings of the Association of Official Agricultural Chemists, it is important, for record and also for reference, that the proceedings of this meeting be accessible to the members of the association. They are therefore inserted in full.

MINUTES.[1]

The meeting took place in the room in Music Hall assigned to the chemical section of the American Association for the Advancement of Science. Dr. Goessmann, the chairman appointed at the Boston meeting, being absent, the convention was called to order by the secretary, A. R. Ledoux.

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[1] Proceedings of the Third Meeting of the Convention of Agricultural Chemists held at Cincinnati, Ohio, August 18, 1881. Published by Jas. H. Folan, New York.

A large number of chemists was present; among them: W. O. Atwater, Middletown, Conn.; A. L. Baker, Baltimore, Md.; B. N. Baker, Baltimore, Md.; H. Carrington Bolton, Hartford, Conn.; G. C. Caldwell, Cornell University, New York; H. Y. Castner, New York City; A. F. Crowell, Woods Hole, Mass.; C. W. Dabney, jr., State chemist, North Carolina; E. W. Davison, Baltimore, Md.; G. W. Davison, Baltimore, Md.; E. P. Dunnington, University of Virginia; Albert C. Hale, Colorado; T. M. Hopke, New York City; R. C. Kedzie, University of Michigan; A. R. Ledoux, New York City; G. W. Lehmann, Baltimore, Md.; Nat. W. Lord, State chemist, Ohio; C. F. S. Lowe, Augusta, Ga.; W. Mager, Baltimore, Md.; J. G. Mattison, New York City; Lockwood Myricke, Boston, Mass.; Paul Schweitzer, University of Missouri; W. Simon, Baltimore, Md.; Eugene A. Smith, University of Alabama; J. Lawrence Smith, Louisville, Ky.; Alfred Springer, Cincinnati, Ohio; C. M. Stillwell, New York City; W. P. Tonry, Baltimore, Md.; G. Henry Williams, Baltimore, Md.; P. B. Wilson, Baltimore, Md.; C. Gilbert Wheeler, Chicago, Ill.; H. C. White, State chemist, Georgia.

Letters were read from Drs. Collier, Goessmann, Johnson, Liebig, Neil, and others, regretting their inability to attend the meeting.

In opening the meeting, Dr. Ledoux recited the history of the convention so far, and read extracts from the reports of the Washington and Boston meetings, showing what had been done. He called attention to the fact that there had been comparatively little complaint since the Washington meeting in regard to the results obtained in the determination of nitrogen, potash, total and soluble phosphoric acid; but that, in spite of honest endeavor on the part of chemists who attended the foregoing meetings to adhere strictly to the methods laid down and adopted by the convention, the determinations of insoluble or reverted phosphoric acid have shown the most unfortunate discrepancies. These discrepancies were clearly as great as they had ever been before there was any attempt to arrive at uniformity in method. He said it had been the experience of many that, working on the same sample, in the same laboratory, two chemists would get results absurdly at variance; and we have, as far as he could see, come no nearer a solution of the difficulties than we were two years ago. As a proof of this, Dr. Ledoux cited a notable example. Soon after the Washington meeting, Dr. Shepard very carefully prepared five samples of artificial fertilizers, and submitted them to a number of chemists specially engaged in agricultural analysis. Each analysis was made in duplicate or triplicate, following most carefully the methods laid down by the Washington convention, with results simply ludicrous, as far as insoluble phosphoric acid was concerned. These analyses were never published, but being privately circulated among some of the chemists who attended the Washington convention, tended to prove what many had found out in the meantime by their own experience, that not yet had a method been reached which, in different hands, would give even approximately uniform results. Dr. Ledoux further stated that another difficulty presented itself in the fact that we have, yielding more or less to our citrate solvent, not only truly "reverted" phosphoric acid, but insoluble phosphoric acid, too, in certain mechanical forms, such as in the Peruvian, Orchilla, Curaçoa, Bat, and other guanos.

Dr. Ledoux further stated what were the rules as to voting, etc., and the programme for business adopted by the convention at Washington, and said that these were adhered to in the adjourned meeting in Boston.

Dr. R. G. Caldwell was then called to the chair.

The minutes of the Boston meeting were read and approved.

The reports of committees being called for, Dr. White, chairman of the committee on permanent organization, reported that their efforts to establish a permanent section of chemistry in the American Association for the Advancement of Science were about to be successful, and that said section would probably be organized on the 19th. After the organization of said section the way would be opened for the organization of a subsection of agricultural chemists. The report was accepted.

Professor Johnson, chairman of the committee of five "to secure the cooperation and research of agricultural chemists on the present methods of fertilizer analyses," not being present and having forwarded no report, and Drs. Caldwell and Atwater being members of said committee, they were called upon by the chair for information. They reported that one or two communications had been forwarded to them by the chairman; but it was their opinion that no definite conclusions had been arrived at by the committee.

It was moved and seconded that the rule for voting adopted at the Washington convention, and adhered to in Boston, should also govern the present convention. This rule is as follows: "Only those who are practicing analytical chemists shall be entitled to vote on the final judgment of this meeting." Drs. Dabney, Schweitzer, and others then opened the discussion in regard to the present methods in use for the determination of insoluble or reverted phosphoric acid, calling attention to the dissatisfaction which existed with the present methods, and also showing the difficulties in the way of arriving at any method which would be universally accepted.

Dr. J. Lawrence Smith said that although he had not recently made any especial investigations with fertilizers he had for years made a study of soils, and he stated that the value of a phosphatic material depended as much on the soil as it did on the chemical condition of the phosphate. He considered that there was no such thing as an absolutely insoluble phosphate from an agricultural point of view, and that after the mechanical condition of the phosphate had been taken into consideration he did not know why some simple method of testing the relative solubility could not be arrived at by agreement. For example, why could we not use a given solution of dilute hydrochloric acid on a given weight of phosphate, allowing it to act for a given time at a given temperature, or some other equally simple plan.

Mr. R. W. L. Rasin, president of the Chemical and Fertilizer Exchange of Baltimore, then presented the following petition:

CHEMICAL AND FERTILIZER EXCHANGE,
RIALTO BUILDING, SECOND STREET,
Baltimore, August 18, 1881.

To the Association of Agricultural Chemists.

GENTLEMEN: The Chemical and Fertilizer Exchange of Baltimore City, of which I have the honor to be president, and the views of which on the question of analysis I respectfully beg to lay before you, is an organization formed for the advancement of the commercial character of this line of trade, and hence actively engaged in watching the closely allied interests of the guano industry, of agriculture, and of agricultural chemistry.

In submitting the following report, I beg leave to state that the exchange, in giving expression to the opinion hereinafter contained, has been guided by the experience of all its members. The grave importance of the decision at which this convention will arrive will, I trust, be readily conceded, and the exchange, it gives me pleasure to announce, entertains the firm belief that you will give its views the consideration to which the practical experience of its members—the manufacturers—appears to be entitled.

The method for the determination of reverted or precipitated phosphoric acid in fertilizers adopted provisionally at the convention of this association at Washington in July, 1880, has now been in practical operation for over two years, and has therefore undergone a thorough trial, and the result has been by no means satisfactory. The experience of the chemists corroborates the experience of the manufacturer. The exchange openly avows that the continuance of the citrate method, under the rules adopted at Washington, would be the cause of great dissatisfaction. Yet, in urging upon you the adoption of the oxalate process, with specified rules, in lieu of the citrate method, the exchange urges this change only and solely for the reason that, in their opinion, only the oxalate method metes out equal justice to manufacturer and farmer. The subjoined analyses will forcibly illustrate how the citrate method, under the Washington rules, does crying injustice to the guano trade and to the farmer. For example, a sample of acid phosphate analyzed by that process, allowing thirty minutes as time of digestion, at a temperature of 40° C., using 50 cc to 1 gram, gave:

$$\left.\begin{array}{r}\text{2.75 per cent soluble}\\ \text{4.54 per cent reverted}\end{array}\right\}\text{7.29 avail. phos. acid,}$$

while the same sample, allowing sixty minutes for digestion at 90° C., applying 100 cc, to 1 gram, showed:

$$\left.\begin{array}{r}\text{2.62 soluble}\\ \text{10.71 reverted}\end{array}\right\}\text{13.33 per cent avail. phos. acid.}$$

This demonstrates clearly that the citrate method, under the rules adopted at Washington, in July, 1879, fails to show the total amount of available phosphoric acid contained in the sample in question. For, if it were not contained therein, then the second analysis could not make it appear, and hence the reality of the existence of 13.33 per cent as against 7.29 per cent, as shown by adherence to the Washington rules, is indisputable. Now the manufacturer, as well as the farmer, is entitled to know the true character of the goods offered for sale or bought; the former, because the analysis determines the commercial value of his goods; the latter, because it is his interest to know what he is actually applying to the soil for its amelioration.

But, in all States where analyses are required and made by the respective departments of agriculture under the Washington rules, the manufacturer is given credit for much less than his goods are intrinsically worth, and the article is deteriorated in the eyes of the purchaser. The former, on the other hand, is led to believe that he is buying an inferior article, when, in point of fact, the actual ingredients far exceed his expectations.

A similar experiment with ammoniated goods gave the following results:

$$\left.\begin{array}{r}\text{Sol. phos. acid 3.59}\\ \text{Reverted phos. acid 8.16}\end{array}\right\}\text{Total avail., 11.75 per cent,}$$

under sixty minutes' digestion, 90° C. and 100 cc to 1 gram, while a strict observance of the Washington rules gave only—

$$\left.\begin{array}{r}\text{Sol. phos. acid 3.59}\\ \text{Reverted phos. acid 5.15}\end{array}\right\}\text{Total avail., 9.73 per cent.}$$

The latter analysis would thus debar from sale this fertilizer in all States where a minimum standard of 10 per cent is required.

How unjust it is to give the manufactured goods the character of an inferior article when they do not deserve it, how unjust to keep from the farmer the correct information as to what he is buying, need not be dwelt upon here. Suffice it to say, that the adoption of a uniform process, which assigns to each article its true intrinsic value, is an imperative demand recognized by all chemists. Nor is this all. The citrate process, under the Washington rule, has been the cause of much fault-finding with chemists, when, in point of fact, the scrupulously conscientious adherence to the above rules was all chemists could be blamed for. Yet they have been not infrequently blamed for incorrectness when they sent analyses to manufacturers which showed considerable less percentage of the various ingredients than the manufacturer full well knew must be—as a matter of fact, was—contained in the goods analyzed from the formula, and proportion in which the ingredients were put in. Thus the method which has been provisionally adopted two years ago has failed in every respect to be more than a fruitful source of complaint and friction.

It appears, therefore, not only expedient, but absolutely necessary to have a uniform method adopted which will fix the commercial value of fertilizers according to their intrinsic value, and assign also proper value to all phosphatic sources. Science must render a service to agriculture by giving the farmer correct reliable information as to what he is buying, and another service to the fertilizer trade by giving their goods the credit they deserve. As is well known, of all constituents of a fertilizer, the most important factor is the available phosphoric acid (whether derived from phosphate of lime or phosphate of iron), and the larger percentage of this is mostly furnished in the reverted or precipitated phosphoric acid.

The oxalate process, which this exchange respectfully urges upon this convention for favorable consideration, has, so far as known to the members of the exchange, been giving general satisfaction, and has, moreover, been used by many chemists in preference to the citrate method on account of its greater accuracy. It appears less liable to error, has shown the products of the manufacturing establishments to be what the farmer's experience confirmed them to be by the practical results obtained, and seems, therefore, open to the least objection.

In confirmation of this opinion I beg to hand you a letter of Dr. G. A. Liebig, and analyses by Drs. Liebig, Shepard, Castner, Collier, and Ledoux, all of which are respectfully submitted for your earnest consideration.

R. W. I. Rasin, *President.*
A. De Ghequier, *Secretary.*

Accompanying the foregoing petition were the following papers:

LABORATORY OF G. A. LIEBIG, PH. D.,
Baltimore, August 16, 1881.

A. DE GHEQUIER, Esq.,
Secretary of Chemical and Fertilizer Exchange, Baltimore.

DEAR SIR: Your favor of the 27th ultimo duly received. You ask me to give expression to such reasons as I may have for preferring the "oxalate" to the citrate method in the determination of precipitated or reverted phosphoric acid in commercial manures.

Upon this subject I think I can hardly say more than I have said already in the correspondence which you have in your possession, covering replies to interrogations propounded by a committee of your exchange. Still, as you desire further expression, I will, at the risk of repetition briefly give a few reasons, which have always been of sufficient weight with me, as a chemist, to cause me to favor the oxalate rather than the citrate method in such determinations. In this connection it is only proper that I should remark that when the subject was under consideration in Washington I urged my views, which have always been as they are now; but being in the minority, I was content with the provisional adoption of the citrate method, feeling sure that time would indicate the correctness and justice of those views more effectually than my simple protest.

In the remarks I make, please bear in mind that when I refer to either method it is with the understanding that it will be carefully and conscientiously followed. You will feel the force of this provision when I tell you it is only within a week or two that a prominent chemist wrote me that he should like to know a method by which all chemists could surely find the same results; to which I answered to the effect that no method would ever insure the correctness of chemists.

In the correspondence before named, I had the pleasure of telling your committee that identical or nearly identical results can be reached by either method. The difficulties, however, of doing the work correctly are more numerous with the citrate than with the oxalate method, and it is laid down that of two given methods the simpler is to be preferred, which is common sense.

One serious difficulty, I have found, is in the fact that the commercial ammonium citrate has a decided acid reaction, rendering the utmost caution necessary, so much so that it became a habit with me to manufacture it for myself; and this precaution becomes more necessary when we are dealing with articles containing ferric and aluminic phosphates. The chemist, not knowing the nature of the article sent him for examination, should, of course, prefer a method which is incapable of discrimination, which, in my opinion, is the case with oxalate, while citrate can discriminate.

It is, of course, idle to pretend at this time that a phosphate containing iron or alumina, if made available, is not as valuable agriculturally and commercially as any other phosphate containing an equal amount of so-called available phosphoric acid. Indeed, it is Mulder who goes so far as to attach the greater value to phosphate of iron, and my personal experience warrants the assertion that it is equally as valuable as phosphate free from such combination.

I do not see that I can say anything more than I have already said to your exchange, except that I hope the approaching meeting of chemists at Cincinnati—to which I am prevented from going—may adopt the method open to the least objection, and, as uniformity in results is the thing so much desired, in my opinion the oxalate method should be adopted provisionally or permanently, as the experience and wisdom of those present may decide.

Hoping this, in conjunction with my former letters, may convey my full meaning,
I am, dear sir, you obedient servant,

G. A. LIEBIG.

UNITED STATES DEPARTMENT OF AGRICULTURE,
Washington, August 5, 1881.

W. E. LAWTON, Esq.

MY DEAR SIR: Your letter of the 2d came duly to hand. Please accept my thanks for your promptness. Now, as to the method of analysis: I can assure you that I am very conservative, and by no means inclined to believe without question that the method adopted is the best one to determine the value of the phosphates analyzed. Of course, I don't mean their agricultural value, for you and other dealers can alone fix their commercial value. But I am aware that experiments alone upon the crop can determine the relative value of these different forms of phosphoric acid, and as a chemist, even, I could not now say what was the difference between that P_2O_5 soluble in excess of hot citrate of ammonia, and that in cold; or that soluble in oxalate solution. In fact, I do not know that there is any difference in its value to the growing plant. I assure you that in any arguments you may have to advance, you will have in me a listener as free from any prejudice as one can be who has been interested in these matters for twenty years. I hope that the very best method known, or capable of being devised, may be adopted for the analyses of these phosphates, and I am wholly with you to that end, and I think no agricultural chemist will be willing to oppose such a result being brought about.

Sincerely, yours,
PETER COLLIER.

MASSACHUSETTS AGRICULTURAL COLLEGE,
CHEMICAL DEPARTMENT,
Amherst, Mass., August 9, 1881.

W. C. LAWTON, Esq.,
President of the Navassa Phosphate Company, New York.

DEAR SIR: I regret that previous engagements do not permit me, during the short period of time left between the arrival of your sample of phosphate (August 8) and the beginning of the Cincinnati meeting, to carry out your request regarding their chemical analysis as directed. As the results of the desired examination can not be secured, to answer your purpose as specified in your letter, as far as time is concerned, I shall not begin the work until otherwise informed. I expect that the committee appointed by me, as chairman of the Association of Agricultural Chemists at their Boston meeting, August, 1880—Profs. S. W. Johnson, Caldwell, Shepard, Collier, and Atwater—to investigate further the various current modes of fertilizer analysis, and to report at the comming meeting at Cincinnati, will do much, directly and indirectly, to reconcile contending views. One of the main objects of our young organization consists in a systematic effort to harmonize the interests of the farming community and the manufacturers of fertilizers, and thereby promote agricultural and industrial progress throughout the country. Please accept my thanks for your confidence.

Very respectfully, yours,
C. A. GOESSMAN.

The accompanying analyses were also exhibited by Mr. Rasin with the following explanation:

With a view of showing the relative merits of the Washington citrate, the "high" citrate, and an oxalate method of determining reverted phosphoric acid, three samples were very carefully prepared from Navassa guano, as follows: One acid phosphate marked "I," one acid phosphate marked "II," and one ammoniated phosphate. These samples were sent for analysis to nine different chemists with the request that they analyze them by the following methods:

A. The Washington method in all its detail.

B. The Washington method, with the exception of using 100 cubic centimeters of citrate solution for one hour at a temperature of 90° C.

C. By using oxalate of ammonia (without any definite instructions as to amount, time, temperature, etc.).

Analyses July and August, 1881.

OXALATE.

	Liebig.	Shepard.	Castner.	Collier.	Ledoux.	Ledoux.[1]
Acid phosphate, sample No. 1.						
Soluble				0.75	1.75	1.79
Precipitated				9.48	10.06	10.22
Total available				10.23	11.81	12.01
Insoluble				4.90	4.00	4.07
Acid phosphate, sample No. 2.						
Soluble	2.35	1.58		1.08	1.59	1.59
Precipitated	9.13	9.77		9.29	8.08	7.98
Total available	11.48	11.35		10.37	9.67	9.57
Insoluble	4.03	3.48		5.10	5.95	6.02

[1] These analyses were made by a different chemist in the laboratory of A. R. Ledoux & Co.

Analyses July and August, 1881—Continued.

OXALATE—Continued.

	Liebig.	Shepard.	Castner.	Collier.	Ledoux.	Ledoux.[1]
Ammoniated sample.						
Soluble	2.78	2.36	....	....	2.02	2.07
Precipitated	6.36	7.38	....	....	8.19	8.00
Total available	9.14	9.74	....	....	10.21	10.07
Insoluble	3.92	2.98	....	....	3.17	3.30
Potash	1.12	1.34	....	....	.98	1.05
Ammonia	2.76	2.89	....	....	2.74	2.72

CITRATE.

[50 cc. 40° C. 30 min.]

	Liebig.	Shepard.	Castner.	Collier.	Ledoux.	Ledoux.[1]
Acid phosphate, sample No. 1.						
Soluble	....	....	2.75	0.75	1.75	1.79
Precipitated	....	....	4.54	6.49	5.73	5.89
Total available	....	....	7.29	7.24	7.48	7.68
Insoluble	....	....	8.52	7.89	8.33	8.40
Acid phosphate, sample No. 2.						
Soluble	....	1.43	....	1.08	1.59	1.59
Precipitated	....	8.10	....	6.29	5.17	5.19
Total available	....	9.53	....	7.37	6.76	6.78
Insoluble	....	5.30	....	8.10	8.86	8.81
Ammoniated sample.						
Soluble	....	2.27	3.58	....	2.02	2.07
Precipitated	....	7.63	5.15	....	5.87	5.88
Total available	....	9.90	8.73	....	7.89	7.95
Insoluble	....	2.82	4.71		5.49	5.42
Potash	....	....	....	....	.98	1.05
Ammonia	....	....	2.98	....	2.74	2.72

CITRATE.

[100 cc. 90° C. 60 min.]

	Liebig.	Shepard.	Castner.	Collier.	Ledoux.	Ledoux.[1]
Acid phosphate, sample No. 1.						
Soluble	....	....	2.62	0.75	1.75	1.79
Precipitated	....	....	10.71	11.79	12.66	12.92
Total available	....	....	13.33	12.54	14.41	14.71
Insoluble	....	....	2.35	2.59	1.40	1.37
Acid phosphate, sample No. 2.						
Soluble	....	1.43	....	1.08	1.59	1.59
Precipitated	....	12.09	....	12.47	12.61	12.52
Total available	....	13.52	....	13.55	14.20	14.11
Insoluble	....	1.31	....	1.92	1.42	1.48

[1] These analyses were made by a different chemist in the laboratory of A. R. Ledoux & Co.

Analyses July and August, 1881—Continued.

CITRATE—Continued.

[100 cc. 90° C. 60 min.]

	Liebig.	Shepard.	Castner.	Collier.	Ledoux.	Ledoux.[1]
Ammoniated sample.						
Soluble	....	....	3.59	....	2.02	2.07
Precipitated	....	....	8.16	....	9.62	9.57
Total available	....	....	11.75	....	11.64	11.64
Insoluble	....	....	1.60	....	1.74	1.73
Potash	....	....	....	....	.98	1.05
Ammonia	....	....	2.98	....	2.74	2.72

[1] These analyses were made by a different chemist in the laboratory of A. R. Ledoux & Co.

The available phosphoric acid, as obtained by the various methods, is inserted below for the sake of showing more plainly the different results:

OXALATE.

	Liebig.	Shepard.	Castner.	Collier.	Ledoux, 1.	Ledoux, 2.
Acid phosphate, No. 1	....	....	....	10.23	11.81	12.01
Acid phosphate, No. 2	11.48	11.35	....	10.37	9.67	9.57
Ammoniated	9.14	9.74	....	....	10.21	10.07

CITRATE.

[50 cc. 40° C. 30 min.]

	Liebig.	Shepard.	Castner.	Collier.	Ledoux, 1.	Ledoux, 2.
Acid phosphate, No. 1	....	....	7.29	7.24	7.48	7.68
Acid phosphate, No. 2	....	9.53	....	7.37	6.76	6.78
Ammoniated	....	9.90	8.73	....	7.89	7.95

CITRATE.

[100 cc. 90° C. 60 min.]

	Liebig.	Shepard.	Castner.	Collier.	Ledoux, 1.	Ledoux, 2.
Acid phosphate, No. 1	....	....	13.33	12.54	14.41	14.71
Acid phosphate, No. 2	....	13.52	....	13.55	14.20	14.11
Ammoniated	....	....	11.75	....	11.64	11.64

NOTE.—The "moisture" in these samples was not reported. The variation in some of the results is undoubtedly due to a difference in the amounts of this constituent.

Mr. Rasin also handed in letters received from a number of chemists expressing their views concerning the oxalate method; in some instances disapproving, in others expressing their willingness to abide by the decision of the convention. Professor Tonry discussed at length the disadvantage of the citrate method, especially emphasizing the injustice which it did to those fertilizers containing large amounts of iron and alumina, and in which the reversion had been caused by these bases instead of lime. Recent experiments were cited which had been made in England, Scotland, and Germany to prove that in many instances, at least, reverted phosphate of iron was as valuable agriculturally and the equivalent of phosphate of lime.

Dr. Simon called attention to the difficulty of obtaining neutral citrate of ammonia, or of maintaining it after it had been secured, and to the marked effect which was exerted by different degrees of alkalinity produced by the addition of ammonia for the sake of neutralization. In contrast to this, he called attention to the stability of oxalate of ammonia.

He was followed by Dr. Ledoux, who pledged himself, as he thought all chemists present would do, to adopt whatever method the convention indorsed. He called attention to the fact that the Washington and Boston meetings had each indorsed the method of Fresenius, Neubauer, and Luck, provisionally for one year; that the year had already expired, and consequently there is now no authorized or official method, so far as American agricultural chemists are concerned. He further called attention to the difficulty of filtering rapidly when the citrate solution is employed, and the consequent discrepancies in point of time which must exist where one solution, filtering rapidly, remained in contact with the solvent for a much shorter period than in the case of another.

Mr. Stillwell said he had used the citrate method for years, and in his hands he finds this method quite satisfactory. He found no difficulty in filtering all solutions containing the citrate rapidly if proper care was used. He considered the oxalate and citrate methods, when carried on under the same conditions, entirely the equivalents of each other in guanos and ordinary superphosphates, excepting when iron and alumina were present. In the latter case he had observed great discrepancies. The citrate process seemed to favor superphosphates free from iron and alumina, which, in his opinion, was rather unjust, as, in his experience, superphosphates containing iron and alumina gave as good results on the field as any others. In his experience two chemists in the same laboratory could use the citrate method with proper care, and have their work agree within reasonable limits. The same was true of the oxalate. In view of the fact that he has tried both methods, and that there was so much dissatisfaction with the citrate, and since he considered them, properly conducted, the equivalent of each other, excepting in the case of iron and alumina phosphates, he had concluded to adopt hereafter the oxalate method.

Professor Lord said he considered that a great part of the discrepancies and variations was due, not so much to the solvent, but to the differences in carrying out the details. He hoped that whatever method was adopted, the details would be so clearly and plainly stated it would be impossible to have any more trouble on this account. He objected to the term "reverted" as not implying the whole truth about the phosphates dissolved by the citrate or oxalate solvent and suggested that chemists adopt the term "Phosphoric acid soluble in —— at —— deg. C." (whatever solvent and temperature might be adopted). He hoped that not only the methods of conducting the analysis would be very clearly and definitely agreed upon, but that even the apparatus to be used in each case should be specified.

Dr. Lehmann stated that his home was in Weisbaden; that he had studied with Fresenius, and was thoroughly familiar with the method of Fresenius, Neubauer, and Luck; that he knows it was adopted mainly with a view to its application for the analysis of bone products and others where little or no iron was present. He too considers the difference in method and time of grinding, stirring, shaking, and filtering, etc., grave causes of discrepancy. In his experience oxalate of ammonia solutions filtered uniformly well.

Dr. Tonry moved that instead of the so-called citrate of ammonia method, the convention do adopt provisionally for one year oxalate of ammonia as a solvent.

Dr. Ledoux stated that there were three interests involved in whatever decision was arrived at by the convention; the interests of manufacturers, the interests of farmers, and the professional interests of the chemists. Since it was apparently impossible, either in this country or in Europe, with our present lights, to arrive at thoroughly satisfactory methods, rendering it impossible to stand upon entirely scientific grounds in the discussion, chemists must consider the commercial points at issue between buyers and sellers, and observe a strictly neutral and just middle ground.

Dr. White said that he had analyzed over 350 samples of fertilizers last year, and found little or no trouble with the Washington method. He not only checks his work by duplicate analyses, but again and again, when the same samples have been returned to him without his knowledge, he has found his previous work corroborated. The new analysis agreed with the former. He acknowledged that his analyses did not always agree with those of other chemists. He stated that we were in possession of but few results making comparison of the oxalate with the citrate method, but he did know that "an especial British commission, after considering the very subject which we are now discussing for over two years, decided that the oxalate process was the very worst of all, in regard to the discrepancies." Since, as has been stated, we are not all agreed as to what shall be included by the term "reverted," he was earnestly opposed to any change, for the present, from the Washington method, but preferred that the whole subject be again referred to a committee, with instructions to make certain tests which could be suggested. He further stated that we could not base a scientific discussion on the analyses of the samples of Navassa guano just reported, because we know nothing as to how they had been prepared, and their number was too few to allow us to generalize from their results. He therefore moved, as a substitute to Professor Tonry's resolution, that the subject be again referred to a committee to investigate and report; and that, until said report shall be made, the Washington method be adhered to.

Dr. Dabney seconded this motion, and he declared that, following the Washington method as nearly as possible, except in a few minor details, his results agreed closely, and he was entirely satisfied with the present system. He, too, had found by experience, that in artificially prepared reverted phosphate of lime, the Washington method was entirely satisfactory, but did not consider it always so in phosphates containing iron.

Professor Atwater said he was pleased to see a spirit of concession and harmony in the convention, and earnestly desired that all interests involved should be carefully considered and harmonized. It being 1 o'clock, he moved that the convention adjourn until 2. Carried.

The convention came together at 2 o'clock and Professor Tonry insisted that his motion should be put. He reiterated his previous statement that, in many legal controversies which he has been engaged as expert, the court favored the oxalate method as used in Baltimore. He simply desired to press his resolution that oxalate of ammonia be adopted, leaving the question of method to be settled in some other manner. He stated that he found the oxalate method best in point of expedition and accuracy.

Dr. Dabney protested against any change, explained the system of obtaining samples in North Carolina and of making analyses.

By courtesy, Mr. Tonry withdrew his resolution temporarily to allow a motion that, in the discussion which should follow, each speaker should be limited to five minutes. Adopted.

Dr. J. Lawrence Smith considered it possible that a fair way out of the difficulty would be to discard the term "reverted" altogether and simply report the amount of phosphate soluble in a given solution, whether of acid or not, as might be agreed upon.

Dr. Dabney again spoke, repeating his convictions that the citrate method would give equally correct, if not better, results than the oxalate method.

Mr. Rasin, on behalf of the manufacturers, stated that all manufacturers had been intensely annoyed and their business interests seriously interfered with by the great difference in the analyses of their goods, and consequently in the great difference in the commercial valuations as applied by the various State departments. While he, as president of the Chemical Exchange, had presented a petition stating candidly that they favored the oxalate method, he wished to say that all they wanted was justice and uniformity, and was willing that the convention should adopt the oxalate method, or the citrate method, with certain changes; either would satisfy the manufacturers.

Drs. Simon, Lehmann, Ledoux, and others followed, discussing the oxalate method. The last stated that since the European chemists have failed to agree on a definite method, examining the question from a chemical standpoint; since they have been discussing the question longer than we in this country, he feared we, too, would find it impossible to agree on any result. He had found it exceedingly difficult to keep the temperature absolutely within the limits prescribed by Fresenius, Neubauer, and Luck, but agreed with Mr. Rasin that we must strive for truth and uniformity.

Dr. Atwater said that the manufacturers had put their case fairly and honestly, and had agreed to abide by the decision of the chemists. It was clear, he thought, that they demanded, and rightly, that our method, if not just, should be at least uniform. He believed that we should make any change which appeared to approach nearer to uniformity than we are at present, and he stated that it seemed to him that the oxalate method was a shade nearer uniformity than the citrate.

Professor Dunnington examined in detail the reports of analyses of Navassa guano which had been submitted to the convention, and pointed out the fact that, although no instruction had been given as to what method should be employed in the ammonium oxalate test, and definite instructions had been given for each of the citrate tests, the discrepancies with the oxalate were considerably less than with either of the citrate methods.

Messrs. Stillwell, Ledoux, and others stated their readiness to abide by the decision of the convention, whatever it might be, as did Drs. Dabney, White, and others.

The question being called for, the chairman decided it was on the substitute offered by Dr. White. Dr. White was requested to put his resolution in writing. It was as follows:

Resolved, That the method provisionally adopted by the Washington meeting be continued for one year, and that the matter of the relative merits of the citrate and oxalate methods be referred to a committee of five, appointed by the chair, to report at a subsequent meeting.

Dr. Ledoux called attention to the extreme improbability of our being able, by any amount of experiment, to arrive at a scientifically accurate method, and considered it necessary to simply agree upon the solvent and method to be employed for the coming year and all stand by the agreement.

The substitute of Dr. White, being put, was lost by the following vote:

Aye—Atwater, Dabney, Lord, White.

No—Baker, Castner, Crowell, Davison, Lehman, Lowe, Mager, Simon, Stillwell, Tonry, Wheeler, Williams, Wilson.

The following gentlemen were absent or refrained from voting:

B. N. Baker, Bolton, Caldwell, Davison, Dunnington, Hale, Hopke, Kedzie, Ledoux, Mattison, Myricke, Smith, Schweitzer, Springer.

A number of gentlemen explained their votes. The motion was lost.

The question then recurred to the original motion of Dr. Tonry—that oxalate of ammonia be substituted for citrate as a solvent.

Professor Caldwell spoke upon this motion. He had listened to the statements of the various chemists with interest. He considered that the protection had been mainly for the benefit of the farmers and that it was time the manufacturers were protected a little. He was, therefore, in favor of trying the oxalate method for a while. It was all a matter of experiment, and if, at the end of the coming year, the oxalate method is found to be unsatisfactory, it can be readily changed.

The resolution of Professor Tonry being put, it was adopted by the following vote:

Aye—Baker, Castner, Crowell, Davison, Dunnington, Ledoux, Lehman, Lowe, Mager, Stillwell, Simon, Tonry, Williams, Wilson.

No—Atwater, Dabney, Lord, Wheeler, White.

Absent or refrained from voting—B. N. Baker, Bolton, Caldwell, Davison, Hale, Hopke, Kedzie, Mattison, Myricke, Schweitzer, Smith, Springer.

Dr. Ledoux offered the following resolution, which was unanimously adopted:

Resolved, That a committee of seven be appointed to consider the best method, and its details, for the determination of insoluble or reverted phosphoric acid by the use of ammonium oxalate; that this committee be instructed to report as soon as possible; and that we pledge ourselves to adopt the method chosen by the committee; that the committee be appointed as follows: One by the chair, three by the president of the Chemical and Fertilizer Exchange, and three to be the State chemists in charge of fertilizer control present at the meeting, viz, Drs. Dabney, Lord, and White.

The chair appointed Prof. W. O. Atwater. The president of the Chemical Exchange appointed Messrs. Lehmann, Simon, and Stillwell.

It was moved that a committee be appointed to continue the investigation of the whole subject of the determination of insoluble phosphoric acid, comparing the various methods now in use and reporting to this convention when prepared to do so.

The chair appointed Messrs. Ledoux, Goessmann, Jenkins, Liebig, and Stillwell.

It was moved that the committee appointed last year to provide for the absorption of the present convention into the American Association for the Advancement of Science, as a subsection of chemistry, be continued with full power to act. Carried.

Mr. Charles M. Stillwell then read the following paper:

On the preparation of superphosphates for analysis.

The few words which I have to say to-day will be confined chiefly to the sampling and preparation of a superphosphate for analysis. The large majority of superphosphates which are received for analysis in our laboratory are freshly made, containing often 22 to 25 per cent of water, full of lumps, hard and soft pieces of bone, meat, gristle, etc., from half an inch in diameter upward. It is impossible by following the plan adopted last year, of breaking up the lumps with the fingers, to get a fair average sample fit for analysis from such a superphosphate.

A case in point will partly illustrate this statement. Last year we sampled a cargo of superphosphate and divided our large average sample into exactly duplicate samples, which we sealed. These were sent to three other chemists of well-known reputation. The results obtained were as follows, reckoning to a dry basis for the sake of a better comparison:

Our result was total phosphoric acid on dry basis, 13.80 per cent; the results of the other chemists were 14.32, 14.64, and 15.21 per cent on dry basis. We were then told by the manufacturer that the cargo should contain 13.75 per cent phosphoric acid on dry basis, as estimated from previous analyses of the ingredients. There can be no doubt that a part at least of this difference was due to imperfect preparation of the sample for analysis, because this superphosphate was one of that class to which I referred a moment ago, a peculiarly difficult one to prepare for analysis.

Until about a year ago, the method adopted by me was one to which I have referred in my paper "On the estimation of precipitated or reduced phosphoric acid in superphosphates" (Proc. of Amer. Chem. Soc., vol. 2, p. 64). This plan was adopted by Dr. Walz many years ago, and later by myself, because it gave such uniformly accurate results. In brief, it was the drying of a large amount of the superphosphate at 100° C., grinding in a mortar, and sifting the dried mass through a sieve of about 100 meshes to the inch. The moisture left in the finely ground sample was estimated, and the results obtained by analysis were calculated back to the original sample. The process of drying reduced the amount of available phosphoric acid by about 0.10 to 0.15 per cent in an ordinary superphosphate, but this lower result might well be neglected on account of the greater accuracy obtained from the use of such a finely ground average sample.

About a year ago, when the use of Orchilla guano, mixed with an acid phosphate or an ammoniated phosphate, was begun by New York manufacturers, we found that this plan would not answer. During the process of drying, the undecomposed carbonate of lime in the Orchilla guano reacted on the soluble and reverted phosphoric acid and reduced a part of it to the insoluble form. For instance, a superphosphate dried at 100° C. gave of insoluble phosphoric acid 4.94 per cent; another portion of the same sample, air dried, gave of insoluble phosphoric acid 4.28 per cent. Another sample, dried at 100° C., analyzed as follows:

	Per cent.
Soluble phosphoric acid	2.68
Reverted phosphoric acid	6.18
Insoluble phosphoric acid	4.94

A portion of this sample, air dried, gave of—

	Per cent.
Soluble phosphoric acid	2.92
Reverted phosphoric acid	6.60
Insoluble phosphoric acid	4.28

Thus showing a loss of 0.66 per cent in the amount of available phosphoric acid caused by drying at 100° C. In an article by S. Drewsen, in Fres. Zeit. f. Anal. Chem., 1881, p. 55, the statement is made that it is immaterial whether a superphosphate is dried at 100° C. or not. But we know that a serious loss is occasioned by such treatment in samples containing Orchilla guanos.

This action of the carbonate of lime upon the available phosphoric acid goes on for weeks after the two are mixed together. An analysis of the sample referred to above as containing 4.28 per cent of insoluble phosphoric acid showed, a month after the first analysis, an insoluble of 5.29 per cent. This sample had been kept in a 2-quart fruit jar in a cool place; but an analysis of the cargo by another chemist, after it arrived at its port and had been kept in bulk for about the same time, showed an insoluble of 6.36 per cent. These insolubles, referred to in the analyses quoted above, were made by the citrate of ammonia method, as adopted two years ago.

The method which we have used for a year past for the preparation of superphosphates is as follows: The whole of the sample obtained, which may be 5 or 8 pounds, is sifted through a coarse iron sieve, with meshes one-quarter of an inch square. The lumps are rubbed through or broken in a mortar, and the whole operation is so rapidly done that no loss of moisture takes place. The well-mixed sample is then averaged, and a part bottled for the determination of the original moisture present, using 20 grams or more, as required.

An average of the remainder is taken and air dried, with no exposure to heat, until it is dry enough to be sifted, after grinding in a mortar, through a sieve of 20 meshes to the linear inch. One-half a gram of such a sample as this is a much better average than 2 grams of a superphosphate prepared without this preliminary drying. It is imperative that the moisture be determined in the prepared sample, no matter how short may have been the time employed for the fine grinding. The results obtained by analysis are then calculated to the original sample, as determined by the moisture present therein.

It being brought to the attention of the convention that the room they occupied was desired by the American Association for the Advancement of Science, the papers of Professor Collier, on "Sorghum and sugar," and of Prof. E. W. Hilgard, on the "Methods of soil analysis," were referred to the chemical subsection of the American Association for the Advancement of Science, where they would be read before a larger audience and receive more attention than could be bestowed upon them in the limited time at the disposal of the present convention.

It was moved that the committee appointed to fix upon the method for determining insoluble or reverted phosphoric acid by means of oxalate of ammonia be instructed to report to the secretary of this convention, and that he shall forward copies of their report to agricultural and other chemists throughout the country.

On motion the convention adjourned, to meet upon call of the chair, provided a meeting was necessary before their organization as a subsection of the American Association for the Advancement of Science.

(After adjournment nearly all the chemists present who were not already members of the American Association for the Advancement of Science joined said association.)

A. R. Ledoux, *Secretary.*

REPORT.

The following is the report of the committee of seven appointed for the purpose of preparing the datails of the oxalate method. The accompanying letter is also published, as it explains somewhat the action of the committee:

Grand Rapids, Mich., *August 25, 1881.*

Dr. A. R. Ledoux,
Secretary Convention Agricultural Chemists,
17 Cedar Street, New York.

Dear Sir: Herewith I send you the minutes of the committee appointed to propose a method for determination of "reverted" phosphoric acid by ammonium oxalate.

As Dr. Stillwell, the secretary of the committee, was obliged to hurry away from Cincinnati, and was not to return directly to New York, and further, as it seemed to him as well as myself desirable to submit the draft of the report to the other members of the committee for approval, I undertook to attend to the latter task and forward the report to you. As I left Cincinnati somewhat hurriedly also, I have not found convenient opportunity to forward it until now.

As you will see, the committee felt that under the circumstances they could do no more now than propose a provisional and temporary plan, but have taken steps toward the proposing of something more nearly adequate to the demanus of the case. It was, however, the feeling of nearly all, I think, that the requisite data will be gotten only after considerable research, and that without them it will be impracticable to propose a method that will command or even be entitled to the following of chemists generally.

Will you please see that Mr. Stillwell has opportunity to correct the proof of the report.

Yours truly,
W. O. Atwater,
Chairman.

REPORT.

Cincinnati, *August 19, 1881.*

Report of proceedings of the committee appointed by the Convention of Agricultural Chemists, August 18, 1881, to prepare directions for the use of ammonium oxalate as a solvent in the estimation of reverted phosphoric acid.

Present, Prof. W. O. Atwater, chairman, Drs. White, Lord, Dabney, Simon, Lehmann, and Stillwell.

This committee, which has been charged with the duty of proposing a method for the estimation of so-called reverted phosphoric acid by the use of ammonium oxalate as a solvent, finds itself at the outset seriously embarrassed; on the one hand by the lack of exact information as to what compounds of phosphoric acid are dissolved by ammonium oxalate and under what conditions; and on the other by the facts that so few of the chemists officially connected with the work of fertilizer analysis were present at the convention, and that all such who were present felt themselves, under the circumstances, unable to favor the proposed change.

In the first place it seems best to the committee to propose for temporary use a method which approaches as nearly as may be to those which have already been employed by some chemists; second, to attempt at least some investigations in the hope of obtaining more light upon the action of ammonium oxalate; third, so soon as they shall thus be placed in condition to warrant it, to suggest a plan for the coming year as they have been directed to do.

1. *Preparation of the sample.*

At least 250 to 300 grams are to be put through a sieve with meshes 3 mm. square (about one-eighth of an inch). All lumps are to be prepared by grinding in a mortar or by cutting until they will pass through the sieve. The whole is well mixed and an average sample bottled for analysis. Special care must be taken during this operation of sifting that no drying of the sample take place.

2. *Determination of the soluble and undecomposed phosphoric acid.*

(*a*) Two grams of the material, transferred to a suitable vessel, are rubbed up with a small quantity of cold water (carefully avoiding any pulverization), transferred to a filter and there washed with cold water, which is added at first in small successive portions until the washings no longer react acid.

Soluble phosphoric acid is determined in the filtrate.

(*b*) The residue upon the filter, containing the reverted and undecomposed phosphates, is carefully washed into a lipped porcelain mortar with the aid of a wash bottle holding 100 cc of a perfectly neutral solution of pure, crystallized ammonium oxalate. Each 100 cc of this solution contains 2 grams of the salt. The coarser portions are allowed to settle, and the fluid, with the suspended particles, is put into a suitable vessel. The residue remaining in the mortar is rubbed to a very fine paste and brought, with the remainder of the ammonium oxalate solution, into the same vessel.

A water bath containing 400 cc of water for each sample treated is brought to a boil, the flame is removed, and the vessel containing the oxalate solution is immediately placed in the boiling water. It is then left in the water bath for sixty minutes, being shaken every ten minutes. At the end of sixty minutes the vessel is removed from the water bath and the contents immediately filtered. The residue is thoroughly washed with cold water and used for the determination of insoluble phosphoric acid.

The chairman and secretary were directed by vote to prepare samples and a schedule for experimental work, and to invite the cooperation of chemists for trial analyses of the samples submitted.

The committee adjourned subject to call by the chairman.

CHAS. M. STILLWELL, *Secretary*.

SUPPLEMENT TO REPORT OF PROCEEDINGS OF THE CINCINNATI CONVENTION OF AGRICULTURAL CHEMISTS.

NEW YORK, *September 23, 1881*.

The following letter from Prof. S. W. Johnson has only just reached the secretary, after the foregoing report was printed and partially distributed. It failed to arrive in time for the Cincinnati meeting, although mailed before the middle of August, owing to misdirection. Owing to the great value attached to anything from Dr. Johnson in the line of agricultural chemistry, and the regret of our convention at the absence of his report, the secretary publishes the letter in this form rather than not at all.

A. R. LEDOUX, *Secretary*.

NEW HAVEN, CONN., *August 14, 1881*.

Dr. A. R. LEDOUX, *Secretary*.

DEAR SIR: I must beg you to present to the Association of Agricultural Chemists my deep regrets at being unable to make any satisfactory report on methods of analyses of superphosphates. I accepted the chairmanship of the committee, with appointment to which I was honored at the Boston meeting, after much hesitation and with many misgivings in view of the probability that I could command neither time nor strength to discharge the duty satisfactorily. Efforts to effect a meeting of the committee failed, because of the wide distances that separated them. Various investigations undertaken in the laboratory of the Connecticut Agricultural Experiment Station, although yielding instructive and valuable results, could not be brought to a satisfactory conclusion, being interrupted by the regular and necessary work of the station, and finally my vacation leisure finds me without the strength to digest the material that has accumulated, and to report the progress attained in a manner at all commensurate with the importance of the subject.

I will state a conclusion that is the result of much experience, viz, that the ammonium citrate method applied as directed by Fresenius, Neubauer, and Luck may easily give reasonably satisfactory results on the low-grade superphosphates usually found in our markets, but that it fails to extract the "reverted phosphate" when their quantity is considered.

Thus from "Curaçao guano," so called, containing 30 per cent of phosphoric acid, 50 cc of ammonia citrate, as exactly neutral as it could be made in one-half hour at 40° with constant and uniform agitation:

Extracted from—	Per cent P_2O_5.
Two grams Curaçao	5.6
One gram Curaçao	9.4
One-half gram Curaçao	13.7
One-quarter gram Curaçao	16.6
One-eighth gram Curaçao	21.0

It is evident, then, that for such phosphates the quantity of solvent must be increased.

In conclusion, I beg to be continued another year on the committee, or preferably to be discharged.

Yours, very truly,

S. W. Johnson,
Chairman of Committee.

After the adjournment of the Cincinnati meeting the interest in the collaboration of the agricultural chemists seemed to die out. There was a certain feeling of antipathy—perhaps it is not well to make it so strong as this, but a strong feeling of incongruity—existing between the trade chemists on the one hand and the official chemists on the other. It was an unvoiced sentiment pervading the organization to the effect that an association composed of trade chemists and official chemists contained elements of instability which would prevent it from ever becoming highly useful. Nevertheless, after the lapse of three years, Mr. Henderson again called a meeting, which was held at Atlanta, Ga.

In his address at the Atlanta meeting, May, 1884, Judge Henderson said:

> I soon became satisfied of two things: first, that the work of the State chemist was entitled to the highest confidence, because verified and sustained by some of the most skillful and experienced chemists in the land, some of whom are now before me; second, that the difficulty was due solely to radically different methods in the laboratory. I thereupon, after consultation with many of you now present, called a convention of representative analytical chemists, official and private, to consider the question. That convention, as you all know, met at Washington, D. C., on July 26, 1880. With its work you are all familiar. A provisional method, now universally known as the Washington method, was adopted by the convention, and generally by the chemists of the country in their laboratories. Adjourning to Boston, the members present formed themselves into a section of the American Association for the Advancement of Science.
>
> At the meeting of the association in Cincinnati on the 18th of August, 1881, the chemical section made some changes in the Washington method, radical in character, with the provision that the method so adopted should be of force during the year. Since that meeting many valuable experiments have doubtless been made by you, and much additional experience gained in the use of methods, and it is to be hoped that you are now prepared to adopt a satisfactory and permanent system. In calling this convention thus early in the season and in advance of the annual meeting of the Association for the Advancement of Science, I have been actuated by a sense of the importance of adopting a uniform and, if possible, a more generally satisfactory method of analysis in time to enable manufacturers, if necessary, to conform to the same in promulgating their work of and for the next season.

Judge Henderson followed up the movement thus begun, but which had remained in abeyance for three years, by issuing a call for the agricultural chemists to meet in the senate chamber of the capitol at Atlanta May 15, 1884.

The names of the gentlemen attending this convention are given in an earlier part of this publication.

The proceedings of the Atlanta convention are contained in a pamphlet edited by Dr. C. W. Dabney, the secretary of the Atlanta meeting, and published at Raleigh, N. C., in 1884. This pamphlet contains 60 pages. It begins with the opening address of Judge Henderson, from which a quotation has already been made.

Dr. C. U. Shepard, of Charleston, S. C., followed Judge Henderson in an introductory address. He said: "Again we are assembled to consider the inconsistencies of agricultural chemical analysis. That they pinch all of us there is no doubt." Dr. Shepard insisted that the chemists having official connection with agricultural colleges and experiment stations and boards of agriculture should take the initiative in establishing uniform methods of procedure. As a commercial chemist he expressed his entire willingness to collaborate with the official chemists in every possible manner, and also to receive and examine samples which might be submitted for comparative analysis. Dr. Shepard also read an important paper entitled "Concerning the nature of reduced phosphoric acid."

At the Atlanta meeting committees were appointed to consider methods of analysis. These committees were three in number, namely:

(1) On methods of determining phosphoric acid, consisting of S. W. Johnson, H. C. White, and W. C. Stubbs.

(2) On methods of determining nitrogen, consisting of P. E. Chazal, A. T. Neale, and J. A. Myers.

(3) On methods of determining potash, consisting of E. H. Jenkins, W. J. Gascoyne, and H. W. Wiley.

Papers were read by F. B. Dancy, on comparison of some methods of determining reverted phosphoric acid; by Professor Johnson, on comparison of the action of ammonium citrate solution on phosphates at different temperatures; by Dr. Shepard, on certain apparatus for the determination of reduced phosphoric acid; by Dr. Wiley, on the action of ammonium citrate on ground bone, and the Gooch crucible in phosphate estimations; by Dr. Shepard, on the insufficiency of the "Washington" method when applied to acid phosphates which have lain long in pile; by Dr. Memminger, on determining reverted phosphates by the use of ammonium oxalate; by Dr. Dabney, on the Ruffle and copper oxid methods of determining nitrogen; by C. B. F. Lowe, on the determination of nitrogen from nitrates by the soda-lime process; by Dr. Memminger, on methods of determining potash.

The reports of the three committees on methods of analysis were received, discussed, amended, and adopted. The bulletin of the proceedings of the Atlanta convention practically forms the first in the series of bulletins containing the methods of analysis of the Association of Official Agricultural Chemists. It was compiled on the plan which was followed for many years thereafter, of having the proceedings and methods contained in the same bulletin, which plan was only abandoned when the volume of matter to be considered was so great as to necessitate two separate publications.

The convention, when it adjourned, agreed to meet in connection with the American Association for the Advancement of Science, in Philadelphia, the following September.

The Philadelphia meeting was held September 8, 1884. Dr. E. H. Jenkins was appointed chairman and Dr. C. W. Dabney acted as secretary. A committee appointed at the Atlanta meeting to consider the advisability of organizing the association as a subsection of the American Association for the Advancement of Science recommended the formation of two associations.

First. The Association of Agricultural Chemists to be entirely distinct from the American Association, to which should be left the discussion of the methods of analysis, etc.

Second. The subsection of the American Association for the Advancement of Science to be open to all agricultural chemists for the purposes of investigation and discussion.

The unanimous opinion expressed in the discussion of this subject was that an organization entirely separate from the American Association would best advance the objects of the convention. A committee, consisting of Messrs. H. C. White, E. H. Jenkins, P. C. Chazal, J. A. Myers, and H. W. Wiley, was appointed to consider the form of organization and instructed to report the following day. The report of this committee, with a few later additions, forms the constitution of the association as it exists to-day.

On September 9 a formal organization took place, the present name of the association was adopted, officers for the following year were elected, and the convention resolved into the first annual meeting of the Association of Official Agricultural Chemists. Committees on phosphoric acid, potash, and nitrogen were appointed, and methods for the determination of phosphoric acid and potash in commercial fertilizers adopted as the official methods of the association.

The bulletin containing the proceedings of this meeting consists of eight pages of printed matter, in which are given the list of officers elected, the constitution, and the methods of analysis adopted officially by the association.

Through the courtesy of Hon. Norman J. Colman, Commissioner of Agriculture, the second annual meeting of the Association of Official Agricultural Chemists was held in the library of the United States Department of Agriculture, beginning September 1, 1885. The officers of the convention were as follows: President, Prof. S. W. Johnson; vice-president, Prof. H. C. White; secretary and treasurer, Dr. Charles W. Dabney, jr.; executive committee, Dr. E. H. Jenkins and Prof. H. W. Wiley.

In the absence of President Johnson, Vice-President White took the chair, and, Dr. Dabney also being absent, Mr. Chazal was requested to act as secretary. Commissioner Colman addressed the members, dwelling briefly on the objects of the association and declaring his hearty sympathy with them. He expressed the hope that the association would not limit its attention to uniform methods of fertilizer analysis, but would extend its work to general chemical analysis, and commended to its special attention the standard of purity of foods and methods of detecting adulteration.

The proceedings of this meeting were published as Bulletin No. 7 of the Division of Chemistry, Department of Agriculture, and embodied, aside from the address of Commissioner Colman, the reports of the various committees appointed at the previous meeting, and several papers on subjects pertaining to the work of the association.

The officers elected for the ensuing year were: President, H. W. Wiley; vice-president, Charles W. Dabney, jr.; secretary and treasurer, Clifford Richardson; executive committee, W. J. Gascoyne and H. A. Huston.

By invitation of Commissioner Colman the third annual meeting of the convention was held at the United States Department of Agriculture, August 26 and 27, 1886, and through his courtesy the proceedings were published as Bulletin No. 12 of the Division of Chemistry.

In Commissioner Colman's letter of invitation to the executive committee he again expressed the hope that the association would extend its investigations to other subjects than those immediately connected with the analysis of fertilizers.

At the opening of the convention the president, Dr. H. W. Wiley, addressed the association, reviewing the work already accomplished, presenting in detail methods of analysis of fertilizers in use in foreign countries and comparing them with the methods adopted by the association. Dr. Wiley closed his address by recommending that the investigations of the association be extended over a wider range of subjects, and expressed the opinion that every problem connected with chemical agricultural analysis was a proper subject for discussion at meetings. He suggested the advisability of appointing a committee to consider the propriety of revising the clause in the constitution which limited the membership and the scope of investigations.

Dr. Wiley's address was followed by the reports on phosphoric acid, potash, and nitrogen, together with various papers on each of the three subjects mentioned.

Up to this time no method for the determination of nitrogen had been adopted as official, and owing to the fact that no one method could be agreed upon it was decided that the association should recognize as official either the Ruffle, Kjeldahl, absolute, or soda-lime methods, when carried out according to the working details to be supplied by the committee. The three methods mentioned were therefore printed with the official methods of the association.

Officers for the following year were elected as follows:

President, E. H. Jenkins; vice-president, P. E. Chazal; secretary and treasurer, Clifford Richardson; executive committee, H. W. Wiley and M. A. Scovell.

At this meeting two additional committees were appointed, namely, on food stuffs and dairy products, and proper methods adopted for the work of each.

In Bulletin No. 16 of the Division of Chemistry are recorded the proceedings of the fourth annual convention of the association, which was held in Washington, August 16, 17, and 18, 1887. Thirty-five members were present, and the meeting was called to order by President Jenkins in the library of the Department of Agriculture.

The president briefly addressed the association, speaking of the importance of the work done, and urging particularly an amendment of the constitution so as to admit as members of the association chemists from agricultural colleges who exercised no official control over the analysis of fertilizers, soils, cattle foods, dairy products, and other materials connected with agricultural industry, and also the chemists from the Treasury Department. This amendment was adopted near the close of the session.

Then followed in their regular order the report of the committee on the analysis of cattle food, the report on dairy products, phosphoric acid, potash, and nitrogen.

In addition to the committees already existing, one was appointed to investigate the subject of the analysis of fermented liquors and another the methods of analysis of sugars.

The officers of the fifth annual meeting of the association were: President, P. E. Chazal; vice-president, W. J. Gascoyne; secretary, Clifford Richardson. John A. Myers and E. H. Jenkins were appointed additional members of the executive committee.

The convention was called in the library of the Department of Agriculture August 9, 1888, Mr. Chazal presiding.

The president omitted the usual address in order to proceed with the business of the convention.

The reports of the various committees were read and discussed; the methods for the work of the additional committees appointed at the previous meeting adopted and ordered to be printed with the official methods of the association. Prof. F. W. Clarke, of the Geological Survey, addressed the members of the association on the desirability of forming a national chemical society, and in harmony with this idea a committee, consisting of Messrs. H. W. Wiley, W. C. Stubbs, and E. A. de Schweinitz, was appointed to represent the association in any action which might be taken in this direction.

At this meeting an amendment to the constitution was adopted which put each of the subjects considered by the association in charge of one person, called a reporter, instead of a committee of three, as was the previous custom.

✓ The proceedings of this meeting were published as Bulletin No. 19 of the Division of Chemistry.

✓ The sixth annual meeting of the Association of Official Agricultural Chemists was held in the Seed Division of the Department of Agriculture, beginning September 10, 1889. The convention was called to order by the president, Prof. John A. Myers. The other officers of the convention were as follows: Vice-president, M. A. Scovell; secretary, Clifford Richardson; executive committee, H. W. Wiley and William Frear.

The session was opened with an address by Hon. Edwin Willets, Assistant Secretary of Agriculture. He called attention to the fact that since the last meeting of the association the Department of Agriculture had become an executive branch of the Government, and dwelt especially on the work of the agricultural experiment stations and the important place held by chemistry in the work.

Secretary Willets was followed by President Myers, who addressed the convention at some length. He spoke of the objects of the association and laid special stress on the necessity of such accuracy and reliability of methods as to compel respect for and trust in the conclusions of the association. He cited statistics showing the influence of the association on commercial activity, and compared its work with that of foreign organizations having the same object in view.

The feasibility of organizing a national chemical society was discussed at length at this meeting, and a motion was made and carried that the association should approve the proposition.

Reports of the various committees were presented and discussed and such action taken as the association deemed necessary.

Clifford Richardson at this time resigned the position of secretary and H. W. Wiley was chosen to fill the vacancy.

✓ Bulletin No. 24 of the Division of Chemistry, containing 235 pages of printed matter, recorded the proceedings of this meeting.

The officers of the seventh annual convention of the association were: President, M. A. Scovell; vice-president, G. C. Caldwell; secretary, H. W. Wiley, with J. A. Myers and E. H. Jenkins as additional members of the executive committee.

✓ The meetings were held in the lecture hall of the United States National Museum, beginning August 28, 1890.

The convention was called to order with President Scovell in the chair, who spoke to the members, congratulating them on the rapid advancement of the organization and the progress made in establishing reliable methods of analysis. A large part of President Scovell's remarks was devoted to recommendations in regard to special lines of the work of the association.

Following the president's address, the regular business of the association was taken up. On the morning of the second day the association was addressed by Hon. Edwin Willets, the Assistant Secretary of Agriculture, in a few well-chosen remarks. The work of the convention was then resumed.

At the date of this convention the work of cattle foods had become so extended that it was deemed necessary to divide the work between two reporters, one to consider foods high in carbohydrates (feeds, grains, and their milling products, etc.), and the other to devote himself to foods low in carbohydrates (coarse fodders, oil seed, residues, etc.). A reporter was also appointed to consider the subject of soil and ash analysis.

The committee appointed on the organization of the national chemical society reported that it had conferred with a similar committee appointed by Section C of the American Association for the Advancement of Science, and suggested that a committee of five be appointed by the Association of Official Agricultural Chemists to cooperate with like committees of Section C of the American Association, the Washington Chemical Society, and similar bodies, in calling a conference of chemists at some central point during the winter to consider the best means of organizing such a society. The report was agreed to, and Messrs. H. W. Wiley, W. C. Stubbs, G. C. Caldwell, William Frear, and H. H. Nicholson were selected to represent the association in the matter.

At this meeting a committee was also appointed on ways and means for securing a more thorough chemical analysis of foods and feeding stuffs, and also one on a chemical exhibit at the World's Columbian Exposition to be held in Chicago.

The proceedings of the seventh annual meeting are incorporated in Bulletin No. 28 of the Division of Chemistry.

On August 13, 1891, the eighth annual convention of the Association of Official Agricultural Chemists was called in the lecture hall of Columbian University. President Caldwell presided and addressed the members, giving a brief review of the history and existing conditions of efforts, both at home and abroad, to establish uniformity of methods of chemical analysis.

The vice-president of the eighth annual meeting was N. T. Lupton; secretary, H. W. Wiley, and E. B. Voorhees and R. C. Kedzie members of the executive committee.

The reports of the various reporters followed in regular order, and many interesting papers were presented relating to subjects under consideration by the association. The meeting was adjourned on the afternoon of August 15, and the proceedings published as Bulletin No. 31 of the Division of Chemistry, a pamphlet containing 253 pages of printed matter.

The ninth annual meeting of the association was called to order by the president, Mr. N. T. Lupton, Thursday, August 25, 1892, in the lecture hall of the United States National Musuem. The other officers of the convention were: Vice-president, S. M. Babcock; secretary, H. W. Wiley; executive committee, C. L. Penny and H. A. Huston.

According to the usual custom, the president opened the association with an address. President Lupton spoke especially on the various methods of analysis adopted by the association, and impressed upon the members the necessity of attaining such uniformity in their processes and accuracy in results as to command the confidence of chemists and interested persons all over the world. The reports on the several subjects were considered by the association. Then followed a discussion of results obtained, amendments to methods employed, and papers presented by other members of the convention. During the afternoon session of the second day, the Hon. Edwin Willits, Assistant Secretary of Agriculture, spoke to the members, congratulating them upon the good work accomplished by the association, and extended them a hearty welcome on behalf of the Department of Agriculture. At this meeting a resolution was adopted to appoint a committee to act in conjunction with committees appointed by the American Chemical Society, the American Association for the Advancement of Science, and the World's Columbian Auxiliary, for the purpose of securing an international congress of chemists during the summer of 1893 at Chicago.

The proceedings of the ninth meeting of the association were published in Bulletin No. 35 of the Division of Chemistry.

In Bulletin No. 38 are incorporated the proceedings of the tenth annual convention of the association. The officers of the meeting were: President, S. M. Babcock; vice-president, E. B. Voorhees; secretary, H. W. Wiley; executive committee, B. W. Kilgore and H. H. Harrington.

President Babcock addressed the association, speaking of the advantage of meeting in Chicago at that time and of coming in contact with representatives of foreign societies of agricultural chemists. He briefly reviewed the methods of analysis employed by the association, commending the progress made, and in some instances pointing out faults in the processes. The regular order of business was then taken up, reports read and discussed, various papers presented, officers for the ensuing year elected, etc.

At this meeting Dr. Wiley called attention to the fact that the association had met with a serious loss in the death of Dr. N. T. Lupton. Dr. Lupton in a sense was a charter member, attending all the meetings and contributing valuable work to the proceedings. Dr. Wiley moved that in honor of Dr. Lupton the members present should rise. Several other members made remarks expressing sorrow at the death of Dr. Lupton, and the motion to rise was unanimously carried. The association adjourned August 26.

On August 23, 1894, the eleventh annual meeting of the association convened in the lecture hall of the United States National Museum, the vice-president, Mr. H. A. Huston, occupying the chair in the absence of the president, Mr. E. B. Voorhees. The other officers of the meeting were: H. W. Wiley, secretary, with B. B. Ross and C. D. Woods as additional members of the executive committee. Mr. Huston read the president's address, in which an outline of the progress of the association from the time of its organization was given, special mention being made of the position the association had taken in regard to cooperating with the National Fertilizer Association in the abolishment of commercial valuation of fertilizers. It was stated that strong grounds had been taken by prominent members of the association against taking any part in national legislation, and a change in the constitution had been made which relieved the association from taking any definite position in the matter. The president in his address referred to the cooperation with foreign chemists authorized at the previous meeting, and stated that as a result of the action of the executive committee in the matter, over 250 leading foreign chemists had been invited to take part in the work of the association. At the conclusion of the address the regular order of business was taken up.

At the afternoon session of the convention Hon. Charles W. Dabney, Assistant Secretary of Agriculture, spoke briefly to the members. He referred to what might be called the first meeting of the association, at Atlanta, and gave pleasant assurances of his hearty support to the organization.

At this meeting a communication was read from the Society of Leather Chemists, asking to be incorporated in the association, and also requesting that a reporter on tannin be appointed. After some discussion the motion was put to the convention and carried, and a reporter on tannin was appointed for the following year.

An amendment to the constitution was also adopted authorizing the president to appoint associate reporters. Their duties were not to be defined, but it was understood that they should prepare themselves to take the place of the reporters.

At this meeting a committee, consisting of Messrs. L. L. Van Slyke, R. de Roode, and W. D. Bigelow, was appointed to edit and rewrite the methods of analysis. A committee of five was also appointed for the purpose of making such changes in the methods of analysis as the discussions during the meeting should prove necessary.

The convention was adjourned August 25, and the proceedings are incorporated in Bulletin 43 of the Division of Chemistry.

The twelfth annual meeting of the association was held in the lecture hall of the United States National Museum, beginning September 5, 1895. The meeting was called to order by the president, Mr. H. A. Huston. The other officers were as follows: Vice-president, B. B. Ross; secretary, H. W. Wiley; additional members of the executive committee, E. H. Jenkins and F. W. Woll. President Huston opened the convention with a few brief remarks, calling attention to some points in the constitution which he thought were not properly interpreted by the members of the association. He strongly advised that more attention be paid by the association to the question of food for man, stating that the only work done was represented in the reports on dairy products and sugar.

The convention, after a short recess employed to fix upon an order of business, was addressed by Hon. J. Sterling Morton, Secretary of Agriculture, in a few words extending a welcome to the organization and expressing his approval of its work and objects. The regular work of the meeting was then pursued.

The sentiment of the convention seemed to be that a committee, to consider in what way the association could be of service in formulating a pure-food law, could do good work, and accordingly such a committee was appointed, consisting of Messrs. H. W. Wiley, H. A. Huston, John A. Myers, and A. S. Mitchell.

The proceedings of the association had gradually assumed such large proportions that at this time it was deemed necessary to issue two separate volumes. Accordingly the proceedings of the twelfth annual convention were published as Bulletin 47 of the Division of Chemistry, while the methods of analysis were published as Bulletin 46. The meeting adjourned September 7.

In Bulletin 49, Division of Chemistry, are published the proceedings of the thirteenth annual meeting of the Association of Official Agricultural Chemists, which convened November 6, 1896, in the lecture hall of the National Museum. The officers of the meeting were: B. B. Ross, president; William Frear, vice-president; H. W. Wiley, secretary, and H. J. Wheeler and F. W. Traphagen additional members of the executive committee.

The president in his address touched briefly upon the progress made by the association in its various branches of work, and referred to the publication of its methods both in French and German as an indication of the recognition of their value by foreign chemists.

The reports on the various subjects followed this address, together with the presentation of papers, discussion of results, etc.

A committee was appointed at this meeting to prepare a suitable set of resolutions on the death of Hon. Edwin Willits, in whom the association had a very strong friend.

The meeting was adjourned November 9.

The fourteenth annual convention was called to order by the president, William Frear, in the lecture hall of the Columbian University October 26, 1897. The other officers of the meeting were: Vice-president, A. L. Winton; secretary, H. W. Wiley; additional members of the executive committee, B. W. Kilgore and Arthur Goss.

The meeting was opened with an address from the president. The tenor of his remarks was that while the prime work of the association was along lines important to the official agricultural chemist, it should also be pushed in a large measure along more distinctly scientific lines. In connection with the work on food adulteration, President Frear cited statistics showing the value of the food products of the country, amount of consumption, etc.

Following the president's address, the regular business of the association was taken up, reports read, papers presented, results and methods discussed, committees appointed, etc. It was decided that the reporters on the various subjects could be more properly called referees, and the name was accordingly changed.

On the morning of the second day the association was addressed by Hon. James Wilson, Secretary of Agriculture, who extended to the organization the courtesy of the Department.

The meeting adjourned October 28, and the proceedings are incorporated in Bulletin 51 of the Division of Chemistry.

The fifteenth annual convention of the association met in the lecture hall of the Columbian University, beginning November 11, 1898. The officers of the meeting were: President, A. L. Winton; vice-president, R. C. Kedzie; secretary, H. W. Wiley; additional members of the executive committee, M. A. Scovell and J. L. Hills.

The meeting was opened with the usual address of the president. Mr. Winton spoke of the purposes for which the association was organized, dwelling briefly on each of the various subjects considered by it. Then followed the regular order of business. A referee was appointed at this meeting to consider the subject of insecticides, and it was also voted that Bulletin No. 46 should be revised so as to include in it the changes made in the methods from time to time.

Mr. M. E. Jaffa, of Berkeley, Cal., was present at the meeting, and extended to the association a cordial invitation to hold its next meeting in San Francisco. He spoke of the advantages of a meeting on the Pacific coast, and assured the members of a hearty welcome from their scientific brethren in the West. The decision of the matter was left to the executive committee.

At this meeting delegates to the National Pure Food Convention were appointed. The last day of the convention Secretary Wilson addressed the members, speaking of the good work of the association and of the necessity for such work. The meeting adjourned November 14, and the proceedings are published in Bulletin 56 of the Division of Chemistry.

The CHAIRMAN. I suppose that no action in regard to this paper is necessary.

The referee on nitrogen not being present, the secretary asked leave to insert the report when received, which was granted.

REPORT ON NITROGEN.

By F. S. SHIVER, *Referee.*

At the suggestion of the secretary of the association, Dr. H. W. Wiley, I will give first a short review of some of the processes which have been suggested for the determination of the availability of organic nitrogen.

Klinkenberg and Stutzer[1] first proposed the pepsin-hydrochloric acid method for the determination of the availability of organic nitrogen.

Morgen[2] has proposed the method of putrefactive fermentation for determining nitrogen availability.

Wilson,[3] among others, has made use of a modified pepsin method, namely, the pepsin-pancreative method, for the determination of the availability of organic nitrogen.

This method was investigated last year by the referee on nitrogen under the name of the modified pepsin method. The results of this investigation, stated in the words of the referee, were as follows:

> The results obtained agree fairly well and compare favorably with the regular pepsin method, except in the case of leather. With this substance the method is worthless on account of the action of sodium carbonate on leather. In addition to this serious objection the method is not likely to be used very often on account of the trouble of manipulation, requiring as it does two digestion periods of twelve hours each and also two filterings, making it very inconvenient to attend to. The filtering is very slow, in some cases requiring two or three filters and one or two days' time.

The pepsin-pancreative method therefore possessed no advantages, but, on the other hand, some disadvantages, as compared with the pepsin-hydrochloric acid method.

The conclusions of the Connecticut Station[4] in regard to the Morgen putrefactive fermentation method for the determination of the availability of organic nitrogen were as follows:

> This test of putrefaction draws the same line between the two classes that was drawn by the pepsin digestion.
>
> Since the putrefactive fermentation method requires more time than the pepsin-hydrochloric acid method, and since it is more objectionable in the manipulations

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[1] Jour. für Landw., 1882, p. 363.

[2] Landw. Versuchs St., 1880, p. 50.

[3] Journal Society of Chemical Industry, vol. 10, p. 118.

[4] Twentieth Annual Report, p. 192.

necessary to carry it out than is the case with the pepsin-hydrochloric acid, our preferences would naturally turn to the pepsin-hydrochloric acid method as compared with the nitrogen putrefactive fermentation method. Under these circumstances, therefore, it is not strange that we were content up to a short time ago to accept the pepsin-hydrochloric acid method as the best one available for the determination of nitrogen solubility.

Several serious objections have been lately urged against the continued use of the pepsin-hydrochloric acid method. It has been shown conclusively that the pepsin-hydrochloric acid method fails to give the correct measure of the availability of the nitrogen in horn meal and hoof meal. This fact, coupled with the time-consuming digestion incident to the carrying out of the process, has stimulated many to investigate this subject for the purpose of finding out, if possible, a more rapid and at the same time more trustworthy method for the determination of nitrogen availability.

Hayes[1] has proposed several new methods for the determination of nitrogen availability, among them fractional treatment with sulphuric acid, digestion in barium hydroxid and in potassium permanganate (alkaline, acid, and neutral solutions).

The conclusions of the author regarding these methods were as follows:

> In conclusion, it may be said that of the various methods tried the digesting in potassium permanganate solutions gives most encouragement.
>
> Whether, if it is in some way modified, it can be made useful, has yet to be proven by comparisons with plant tests on the same material.

The permanganate methods, thus suggested, were taken in hand by the nitrogen referee in 1896, but were not thoroughly tested for lack of time. Among the recommendations of the referee for this year (1896) we find the following:

> That the nitrogen reporter for 1897 be requested to investigate further the potassium permanganate method for determining the availability of organic nitrogen * * *.

The referee on nitrogen for 1897, pursuant to the wishes of the association, subjected the potassium permanganate methods (alkaline, acid, and neutral solutions) to a thorough test. As a result of this work no definite conclusions could be drawn, but the methods were of sufficient promise to induce the referee to recommend "that the potassium permanganate method for determining the availability of organic nitrogen be further studied next year, with especial reference to material of known inferiority.'

The referee on nitrogen for 1898 has again taken up this matter, and has made a further study of the potassium permanganate method, in comparison with the pepsin-hydrochloric acid method and a modification of the pepsin method, as suggested by Mr. Patterson, of Maryland. The potassium permanganate method, suggested for use this year (1898), consisted of a half-hour digestion in a 2 per cent neutral solution, the acid and alkaline solutions having been shown to be unsatisfactory in not giving concordant results. The referee, commenting on the results obtained by this method, remarks:

> By an examination of Table IV it will be seen that there is a great lack of agreement in the results obtained by the different analysts, and on some materials it seems almost impossible to obtain concordant results in the same laboratory.

It was thought by some at this time that it would be desirable, instead of using the same amounts (1 gram) of material in all cases, to use equal amounts of nitrogen as a basis.

In the methods of Jones and Street, to be described later, 4½ and 7½ per cent of nitrogen, respectively, are used as a basis for the two methods. Among the recommendations of the referee for 1898 we find the following:

> The only recommendation which your referee wishes to make on this subject is that the potassium permanganate methods for the determination of the availability of organic nitrogen be further studied next year, especially some modification of the alkaline permanganate method.

As a result of all this work two well-defined methods, involving the use of potassium permanganate, have been worked out. I refer to the Street method, in which use is made of a neutral solution, and to the Jones method, in which use is made of an alkaline solution.

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[1] Bulletin 47, Division of Chemistry, U. S. Department of Agriculture.

Both of these processes are apparently quite promising, and a detailed discussion of them will follow the results reported later on in this report.

WORK OF AVAILABILITY OF ORGANIC NITROGEN FOR 1899.

Early in March the following circular letter was sent out to all those who were supposed to be interested in this line of work:

MARCH 15, 1899.

DEAR SIR: I desire to know if you will cooperate with me in the work on nitrogen for the association this year. The work will be limited to a further study of methods for the determination of the availability of organic nitrogen. In accordance with the wishes of the association the permanganate method will be further studied in this connection.

There will probably be eight or ten samples of representative organic nitrogenous materials. If possible these will be samples of material on which vegetation tests have been made.

Please let me know at your earliest opportunity your wishes in regard to the matter.

Very truly,

F. S. SHIVER, *Referee on Nitrogen.*
W. R. PERKINS, *Associate.*

From this circular nine favorable replies were received.

In April, accordingly, seven samples were sent out to each party expressing a desire to take part in the work.

Of the nine chemists who expressed a willingness to undertake the work seven have sent in reports more or less complete.

These samples, with the exception of No. 1, were secured from the New Jersey station through the kindness of Mr. J. P. Street.

Along with each set of samples there was sent a letter containing the directions to be used in the different methods.

In the preparation of the samples, I would say that they were ground to pass a sieve having circular perforations 1 millimeter in diameter, as directed by the methods of the association.

The samples were then mixed thoroughly, and all samples were taken out at once from the same pile.

While the referee was directed by the association only to investigate the alkaline-permanganate method, yet it was thought desirable to include also the Street method, which, from the results obtained at the New Jersey station, bids fair to be a useful process in this connection, and also the pepsin-hydrochloric acid method, which for years has been the standard.

The letter of directions which accompanied each set of samples was as follows:

DEAR SIR: I have sent you by express seven samples of organic nitrogenous material for the work on availability for the association.

No. 1 is cottonseed meal; No. 2 is ground fish; No. 3 is dried blood; No. 4 is tankage; No. 5 is ground bone; No. 6 is hoof meal; No. 7 is garbage fertilizer.

First determine total nitrogen in all samples.

Then determine availability of organic nitrogen by the following methods:

I. *Neutral permanganate method* (Street).—Into a 600 cc Erlenmeyer flask weigh an amount of the material equivalent, approximately, to 0.0750 gram of nitrogen. Digest this with 100 cc of permanganate of potash solution (16 grams $KMnO_4$ to 1,000 cc of water) in a steam bath or a water bath, where the water is kept at a constant boil for thirty minutes.

Filter on a folded filter without pressure, and wash thoroughly with cold water.

Then determine the nitrogen in the residue by the ordinary Kjeldahl method.

II. *Alkaline permanganate method* (Jones).—Weigh an amount of the material equivalent to 0.0450 gram of nitrogen into a 500 cc flask and add 100 cc of an alkaline permanganate solution (16 grams $KMnO_4$ and 150 grams of NaOH to a liter). The flask is connected with a distilling apparatus, and its contents digested for an hour below the boiling point, and then distilled for an hour. The ammonia evolved is titrated as usual. If you have time I would like to have the pepsin-hydrochloric acid method tried also.

Proceed as follows: Weigh 1 gram of sample into a 150 cc flask and add 100 cc of pepsin-hydrochloric acid solution.

This solution is prepared by mixing 5 grams of Parke and Davis's pulverized pepsin (guaranteed to dissolve 3,000 times its weight of freshly coagulated egg albumen) in 1,000 cc. of hydrochloric acid diluted to a strength of 1 per cent.

The flasks are then kept for twenty-four hours loosely corked in a water bath, having a constant temperature of 40° C. At the end of the second, fifth, eighth, and eleventh hours, 2 cc of a 10 per cent hydrochloric acid solution are added, shaking the flask thoroughly at the same time.

After twenty-four hours' digestion, filter, wash four or five times, using 20 to 30 cc of water for each washing, and determine nitrogen by the Kjeldahl method in the washed and dried residue.

Please let me know your results as soon as possible.

Yours truly,

F. S. Shiver, *Referee on Nitrogen.*
W. R. Perkins, *Associate Referee.*

I.

We consider first the determinations of total nitrogen by the Kjeldahl method.

(A) *Total nitrogen by Kjeldahl method.*

Table 1.—*Results on total nitrogen by the different analysts.*

Analyst.	Cotton-seed meal.	Ground fish.	Dried blood.	Tankage.	Ground bone.	Hoof meal.	Garbage fertilizer.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
T. C. Trescot, Department of Agriculture	6.61	8.69	[1]12.67	6.49	[1]3.31	[1]14.26	3.16
J. A. Bezzell, North Carolina station	6.79	8.81	13.66	6.51	3.55	14.70	3.20
A. T. Eskridge, jr., Virginia station	6.79	[1]8.37	[1]13.05	[1]6.29	3.76	14.40	3.06
F. B. Carpenter, Richmond, Va	6.90	8.96	13.72	6.50	3.61	14.78	3.20
J. P. Street, New Jersey station	6.74	8.80	13.60	6.65	3.40	14.47	3.20
J. W. Ames, Ohio station	....	8.79	[1]13.29	6.45	3.33	14.33	3.13
W. R. Perkins, Mississippi station	6.55	8.78	13.47	6.50	[1]3.25	14.49	3.11
C. H. Jones, Vermont station	6.78	8.79	13.69	6.59	3.39	14.66	3.23
F. S. Shiver, South Carolina station	6.85	8.81	13.85	6.40	3.68	14.94	3.26
Average	6.75	8.80	13.66	6.51	3.53	14.59	3.17

[1] Omitted from the average.

The results in Table I are all by the Kjeldahl method, with the exception of those reported by Messrs. Trescot and Ames, which were obtained by the Gunning method.

These results, in so far as they apply to the cottonseed meal, ground fish, tankage, and garbage fertilizers, are quite satisfactory. The results on blood, ground bone, and hoof meal are quite variable. While these samples were not ground quite as fine as they could have been, yet it does not seem possible to explain the differences on that ground. I myself had no trouble in obtaining closely concordant results in duplicates, and in fact none seemed to have had any difficulty in this direction, judging by the results in my hands.

In regard to the blood and hoof meal, in which large quantities of nitrogen are present, I would say that I believe that the low percentages found by some are due no doubt to one of two causes: (1) To insufficient digestion. I think it has been pretty well established that unless the digestion be continued for some time after the solution has lost its color, the results obtained are too low. I myself have noticed this in the case of cottonseed meal, and Gerlach and others have called attention to the same thing. (2) To an insufficient amount of acid in the receiver in which the ammonia evolved is caught.

Unless a considerable amount of acid above that necessary for saturating the ammonia be present, a loss is sustained also. In the case of the sample of blood here, in the first analysis, I used a very small excess of acid, and in the second analysis I used a considerable excess, with the result that about four-tenths more of nitrogen were found than in the first analysis.

It is evident from these results that even with an old-established method, like the Kjeldahl, great care is to be exercised in the preliminary digestion with sulphuric acid, and also in the manner in which the ammonia evolved is received.

(B) *Digestion of organic nitrogen by the alkaline permanganate method* (Jones).

This method has been described in the letter of instructions quoted already.

Table 2 gives the results obtained by the different analysts with this method. This table gives the percentages of nitrogen evolved:

TABLE 2.—*Results on digestion of organic nitrogen with alkaline permanganate of potash (Jones).*

Analyst.	Cotton-seed meal.	Ground fish.	Dried blood.	Tank-age.	Ground bone.	Hoof meal.	Gar-bage ferti-lizer.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
T. C. Trescot, Department of Agriculture ..	2.50	5.79	7.35	3.70	[1] 2.02	9.84	0.65
J. A. Bezzill, North Carolina station	[1] 3.28	5.96	9.74	[1] 4.23	2.38	11.17	0.76
A. T. Eskridge, jr., Virginia station	2.66	5.50	9.04	3.79	2.58	11.32	0.67
J. P. Street, New Jersey station	2.82	5.62	9.57	3.70	2.49	10.64	0.51
J. W. Ames, Ohio station	....	5.76	8.26	[1] 0.89	[1] 0.44	[1] 10.96	....
W. R. Perkins, Mississippi station	2.73	[1] 4.24	8.57	3.39	2.25	8.42	0.73
C. H. Jones, Vermont station	2.96	[1] 5.21	8.66	3.50	2.31	9.03	0.60
F. S. Shiver, South Carolina station	2.78	6.01	9.63	[1] 4.08	[1] 2.89	....	0.67
Average	2.74	5.77	....	3.61	2.40	....	0.65

[1] Omitted from the average.

The figures in this table are somewhat variable, especially as regards the dried blood and hoof meal, for which reason I have made no attempt to give averages for these materials.

From the results in my hands it appears that many of the analysts experienced difficulty in securing concordant results by this method.

For myself, I would say that some of the results obtained by me were very unsatisfactory. In carrying out this method everyone must be impressed with the difficulties involved in keeping conditions the same in all cases. With the small amount of liquid (100 cc) used it is very difficult to prevent the solution from boiling in the preliminary digestion. Moreover, in the subsequent digestion I perceived great difficulty, in some cases at least, in preventing excessive bumping. This was especially true of the digestion of the dried blood and hoof meal.

In some cases I used pumice to prevent this bumping, but found this ineffectual.

Table 3 gives the percentages of availability of organic nitrogen, as determined by the alkaline potassium permanganate method (Jones). This data was secured by using the figures given in Tables 1 and 2.

TABLE 3.—*Availability of organic nitrogen by the alkaline permanganate of potash method (Jones).*

Analyst.	Cotton-seed meal.	Ground fish.	Dried blood.	Tank-age.	Ground bone.	Hoof meal.	Garbage fertilizer.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
T. C. Trescot, Department of Agriculture .	37.82	66.62	[1]58.01	57.01	[1]61.02	69.00	20.56
J. A. Bizzell, North Carolina station	[1]48.30	67.65	71.30	[1]64.97	67.04	75.98	23.75
A. T. Eskridge, jr., Virginia station.......	39.17	65.71	69.27	60.25	68.61	78.61	21.89
J. P. Street, New Jersey station	41.83	63.86	70.36	55.63	73.23	73.53	[1]15.93
J. W. Ames, Ohio station	....	65.63	62.15	[1]13.79	[1]13.21	76.48	....
W. R. Perkins, Mississippi station.........	41.67	[1]48.29	63.62	52.15	69.23	[1]58.10	23.47
C. H. Jones, Vermont station..............	43.65	[1]59.27	63.25	53.11	68.14	[1]61.59	[1]18.40
F. S. Shiver, South Carolina station.......	40.58	68.21	69.53	[1]63.75	[1]78.53	....	20.55
Average	40.78	66.28	67.06	55.63	69.25	74.72	22.04

[1] Omitted from the average.

The figures in this table are fairly satisfactory, with the exception of those given for tankage and ground bone.

An inspection of the figures, however, reveals one striking defect at least in this method. That defect is that this method fails to express the true relative availability of the nitrogen contained in cotton-seed meal. We might expect from this table cotton-seed meal to be a very inferior product, while on the other hand experience in the field has proven exactly the contrary.

Moreover, from this table we might expect ground bone to be a great deal more available than tankage or dried blood, a fact which is contrary to the results of practical experience.

With the mention of these objections to the method, which appear fatal to my mind, I invite your attention now to the consideration of the results obtained by the neutral permanganate process (Street).

(C) *Digestion of organic nitrogen by the neutral permanganate method.*

This method has been described in the letter of instructions, already quoted.

Table 4 gives the results obtained by the different analysts with this method.

The results given in this table refer to the percentage of nitrogen contained in the residue (insoluble nitrogen):

TABLE 4.—*Results on digestion of organic nitrogen with neutral permanganate of potash (Street).*

Analyst.	Cotton-seed meal.	Ground fish.	Dried blood.	Tank-age.	Ground bone.	Hoof meal.	Garbage fertilizer.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
T. C Trescot, Department of Agriculture..	1.66	0.84	1.03	[1]1.28	1.31	[1]1.54	1.64
J A Bizzell, North Carolina station.......	1.45	0.73	0.69	0.73	0.93	0.87	1.57
J. P. Street, New Jersey station............	1.36	[1]1.20	0.65	[1]1.55	[1]1.61	[1]1.59	1.79
J. W. Ames, Ohio station	....	0.65	0.66	0.93	1.44	[1]1.40	1.72
W R Perkins, Mississippi station..........	1.52	0.78	0.82	0.95	1.33	0.92	1.57
C. H Jones, Vermont station...............	1.47	0.56	[1]0.27	1.05	[1]2.45	0.77	....
F. S. Shiver, South Carolina station........	1.44	0.50	[1]0.30	0.71	1.14	0.84	1.55
Average	1.48	0.67	0.77	0.87	1.23	0.85	1.64

[1] Omitted from the average.

The results by this method are quite satisfactory, on the whole. The results on the cotton-seed meal, ground fish, and garbage fertilizer are very uniform. Practically everyone seemed to secure good duplicates with the method. I myself secured excellent duplicates with all the samples except the cotton-seed meal. My figure given above for the cotton-seed meal is the mean of two results, which did not agree as well as I wished, but lack of time prevented me from doing any more work with the sample.

I should like to call attention here to the necessity of determining nitrogen in the paper used for filtration in this method. In my work I used Schleicher and Schüll's folded filters, No. 258, 18½ centimeters. Two blank determinations were made on the paper in question, and as a mean of these determinations 0.0016 gram of nitrogen was found. All my results were corrected for this amount of nitrogen in the papers.

This seems at first sight quite a small amount of nitrogen, and so it is; but when we calculate availability this amount of nitrogen would alter figures considerably, and hence must be taken into consideration.

Table 5 gives the availability of organic nitrogen, as determined by the neutral potassium permanganate method (Street). In the preparation of this table use was made of the data obtained in Tables 1 and 4:

TABLE 5.—*Availability of organic nitrogen by the neutral potassium permanganate method (Street).*

Analyst.	Cotton-seed meal.	Ground fish.	Dried blood.	Tankage.	Ground bone.	Hoof meal.	Garbage fertilizer.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
T. C. Trescot, Department of Agriculture..	74.88	90.33	91.87	80.27	60.42	89.20	48.10
J. A. Bizzell, North Carolina station........	78.64	91.71	94.94	88.78	[1]73.80	94.08	50.93
J. P. Street, New Jersey station	79.82	[1]86.36	95.22	[1]76.69	52.64	89.01	44.06
J. W. Ames, Ohio station....................	....	92.60	95.03	85.58	56.75	90.23	45.04
W. R. Perkins, Mississippi station..........	76.79	91.11	93.91	85.38	59.07	93.65	49.51
C. H. Jones, Vermont station................	78.31	93.62	98.02	84.06	[1]27.72	94.74	....
F. S. Shiver, South Carolina station........	78.97	94.32	97.83	86.40	[1]69.02	94.37	52.45
Average	77.73	92.28	95.26	85.07	57.22	92.18	48.34

[1] Omitted from the average.

The results here again are very encouraging, when we take into consideration the fact that very small differences in the percentages of nitrogen found make comparatively large differences when calculated to percentages of availability. From all these results I think we can say that this method is very promising; promising, not only because of the uniformity of the results obtained by its use, but also because of the agreement of these results with those of vegetation tests.

(D) *Results obtained on digestion of organic nitrogen with pepsin-hydrochloric acid.*

This method, too, has been described in the letter of instructions already quoted. Only one analyst, Mr. T. C. Trescot, U. S. Department of Agriculture, has found time to comply with my request in regard to this method. Your referee, I am sorry to say, was unable to do any work with this method for lack of time.

Table 6 gives the results on digestion of organic nitrogen with this method by Mr. Trescot.

The figures refer to the percentages of nitrogen found in the insoluble residue (insoluble nitrogen).

TABLE 6.—*Results on digestion of organic nitrogen with pepsin-hydrochloric acid.*

Analyst.	Cotton-seed meal.	Ground fish.	Dried blood.	Tankage.	Ground bone.	Hoof meal.	Garbage fertilizer.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
T. C. Trescot, Department of Agriculture ...	0.65	1.33	0.42	1.84	0.22	10.22	1.62

Table 7 gives the percentages of availability of organic nitrogen as determined by this method.

This data was obtained by using the figures in Tables 1 and 6.

TABLE 7.—*Availability of organic nitrogen by the pepsin-hydrochloric acid method.*

Analyst.	Cotton-seed meal.	Ground fish.	Dried blood.	Tankage.	Ground bone.	Hoof meal.	Garbage fertilizer.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
T. C. Trescot, Department of Agriculture..	90.16	84.69	96.60	71.64	93.35	28.33	48.73

By comparing these figures with the figures obtained for the availability of organic nitrogen by the Street method (Table 5) we find that there is a very close agreement between the figures for dried blood and garbage fertilizer, as obtained by the two methods. We find also that while the pepsin method only shows an availability of 28.33 per cent for hoof meal, the Street method shows an availability of 92.18 per cent, which agrees much better with the figures obtained by vegetation tests.

As the merits and demerits of the pepsin method have been considered already in the first part of this paper we will desist from any further consideration of the same here.

II.

After having sent the samples out to all those who had signified their intention of cooperating with me in the work, I received a letter from Mr. J. P. Street, of the New Jersey Station, who said he thought better results would be secured if the samples were ground finer. As I have said previously, all the samples were ground, as the association directs, to pass a sieve having circular perforations 1 millimeter in diameter.

Nevertheless I wrote Mr. Street, and subsequently all others who had received samples, to first make the determinations suggested in my letter of instructions on the samples as received, and then to regrind them so as to pass a sieve having 50 meshes to the inch, and make all the determinations suggested again on this reground material. Three analysts have complied wholly or in part with this request.

Table 8 gives the results on digestion of organic nitrogen with alkaline permanganate on the samples reground as directed. These figures represent the percentages of nitrogen evolved.

TABLE 8.—*Results on digestion of organic nitrogen by alkaline permanganate of potash (Jones) after regrinding.*

Analysts.	Cotton-seed meal.	Ground fish.	Dried blood.	Tankage.	Ground bone.	Hoof meal.	Garbage fertilizer.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
T. C. Trescot, Department of Agriculture...	2.30	5.43	7.35	3.44	2.05	10.56	0.61
J. P. Street, New Jersey Station............	2.76	5.64	9.54	3.68	2.47	11.29	0.72
C. H. Jones, Vermont Station	3.18	5.50	9.54	3.70	2.45	10.16	0.63

The results in all cases (except Mr. Trescot's) are somewhat higher.

Table 9 gives the results on digestion of organic nitrogen by neutral permanganate on the samples reground as directed. The figures refer to percentages of nitrogen in the residue.

TABLE 9.—*Results on digestion of organic nitrogen by neutral permanganate of potash (Street) after regrinding.*

Analyst.	Cotton-seed meal.	Ground fish.	Dried blood.	Tankage.	Ground bone.	Hoof meal.	Garbage fertilizer.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
T. C. Trescot, Department of Agriculture	2.84	0.87	1.16	1.18	1.19	0.90	1.97
J. P. Street, New Jersey Station	1.45	1.01	0.78	1.18	1.10	1.15	1.79

Mr. Trescot's figures on the whole are higher; Mr. Street's lower.

Table 10 gives the results on digestion of organic nitrogen by the pepsin-hydrochloric acid method on the reground samples. The figures here refer also to the percentage of nitrogen in the residue.

TABLE 10.—*Results on digestion of organic nitrogen with pepsin-hydrochloric acid, after regrinding.*

Analyst.	Cotton-seed meal.	Ground fish.	Dried blood.	Tankage.	Ground bone.	Hoof meal.	Garbage fertilizer.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
T. C. Trescot, Department of Agriculture	0.77	1.33	0.48	1.98	0.21	9.85	1.59

The results here are about the same, with the exception of the hoof meal, which is considerably lower.

Increased grinding, therefore, augments to a slight degree the nitrogen availability, and hence it may be well to have it understood that in the future all work of this character must be done on samples which have passed a sieve having 50 meshes to the inch.

This increased grinding, however, it must be understood is not necessary in order to secure uniform results, as this can be accomplished on coarser samples, as shown by the results in this paper.

In conclusion I desire to express my appreciation of the efforts of all those who have assisted me in this work, and also to apologize to the association for the incomplete report here submitted.

I desire further to thank the association for the honor it has allowed me of serving it for two years in the capacity of associate referee on nitrogen. I hope my efforts have not been entirely unappreciated.

RECOMMENDATIONS.

I would recommend that the neutral permanganate of potash method (Street) be referred to the referee on nitrogen for 1900 for further trial.

All of which is respectfully submitted.

The CHAIRMAN. The report on potash by Mr. B. B. Ross, of North Carolina, is next in order.

Mr. WILEY. I have Mr. Ross's paper which I will read. I will first read a letter which I have received from him.

Alabama Polytechnic Institute,
Auburn, June 28, 1899.

Dr. H. W. Wiley,
Secretary Association of Official Agricultural Chemists, San Francisco, Cal.

Dear Dr. Wiley: I herewith inclose my report on potash, which was prepared under great difficulties and in great haste, owing to the press of work on hand at present.

The analytical data presented are somewhat meager, and some of the results arrived so late that it is impossible for me to tabulate them in time to have them manifolded.

The results I send are averages as reported by each analyst, and in this form they can be placed on a blackboard easily. I will send fuller results to you at Washington, but trust these will answer the purposes of the association.

In accordance with your suggestion, I include with my report a review of the potash work of the association up to this time, though it is quite possible that I have overlooked some points of interest.

With kindest regards to the members of the association, including yourself, and regretting that I can not be present at the San Francisco meeting, I am,

Yours, very truly,

B. B. Ross.

P. S.—At last moment was unable to average results.

REPORT ON POTASH.

By B. B. Ross, *Referee.*

At the suggestion of the secretary of this association, the referee presents, in connection with his report on potash, a short résumé of the work on this subject performed by the association since its inception fifteen years ago.

As is known to many, the organization of this association was preceded by a convention of agricultural chemists which was held in Atlanta in May, 1884, and although methods for the determination of phosphoric acid were adopted, no action was taken with regard to potash methods. The minutes of this meeting, however, indicate that the subject was discussed to some extent, and if we are to judge from the reports of the discussions, some very crude methods of potash determination were in use in some of the laboratories at that time.

Several years prior to this time a convention of agricultural chemists was held in Washington (July 28, 1880), and the following method for the determination of potash in fertilizers was recommended: "Solution in water, removal of sulphates, phosphates, and magnesia by barium hydrate, clearing with oxalate or carbonate of ammonia and precipitating with platinum chloride."

This method, whose brevity allowed considerable latitude for the individual analyst, was essentially the same as that followed in many laboratories in this country prior to the organization of this association, though in most cases barium chloride was employed as a precipitant in connection with barium hydrate.

At the first meeting of the association in Philadelphia, in 1884, methods for potash as well as phosphoric acid were adopted, the process for the determination of the former in fertilizers corresponding closely with the present optional method, although hydrochloric acid was employed along with water in effecting the solution of potash, and the method also differed in the particular that neither oxalic acid nor ammonium oxalate was employed in the precipitation of lime, and two separate treatments with ammonium carbonate were required, accompanied by an additional filtration, evaporation, and ignition.

At the Philadelphia meeting, Dr. H. W. Wiley was appointed chairman of the committee on potash, and at the first Washington meeting thereafter presented a most comprehensive report, reviewing all of the methods of importance for potash determination in use at that time, and also calling attention to various methods which had been proposed during the few years preceding. In this report attention was called to the fact that the method described by Stohmann about twenty years before, and extensively employed in Germany in the analysis of crude kainit, is essentially the same as that which found its way into use as the first official method of this association.

A reference to the report alluded to reveals the fact that the unification of methods of analysis in the different countries had made but little progress, and the methods in use in any given country for commercial work showed wide divergences as regards details, even where the methods involved the same principle.

As early as 1875 steps had been taken by the British Association for the Advancement of Science looking toward the securing of uniformity in methods of analysis of fertilizing materials, and a commission appointed for the purpose endeavored to secure from the leading chemists engaged in commercial analysis a statement as to the methods employed in their laboratories for potash and phosphoric acid work. They were not altogether successful, however, in their request for information of this character, as one prominent firm of commercial chemists declined to give the information desired, "as we do not think ourselves called upon to publish our methods of analysis, which we have perfected after long and careful investigation, for the benefit of those who have not taken this trouble." Fortunately chemists of this character are the exception rather than the rule, and the committee referred to, as well as the Society of Public Analysts, have been able to do much toward the harmonizing of diverse methods of analysis in spite of opposition from such sources. As the result of the work of this committee, the process of Wallace, Tatlock, and Clark was brought into notice (Chem. News, XXXII, 201), the prominent feature of this method being the washing of the double chloride of potassium and platinum with a solution of platinum chloride.

The report of Dr. Wiley in the proceedings of the second annual convention of the Association of Official Agricultural Chemists covers the literature of potash determinations up to that time so thoroughly that it is unnecessary to refer to the processes in use prior to that date In this report he refers to the process proposed by David Lindo, which was the basis of our present official method. The method of Lindo was first communicated to the scientific public through the Chemical News in 1881, and for several years failed to attract any considerable attention from analytical chemists.

The method was originally proposed for the determination of potash in crude potash salts, and was especially designed to overcome the difficulties attendant upon the determination of potash when present as sulphate, or in the presence of sulphates of other metals. At the meeting in 1885 Mr. Thomas S. Gladding presented a paper in which were embodied results of tests of Lindo's original method, and in connection therewith he submitted a modified method applicable to mixed fertilizers. This method was printed in the proceedings of the convention for the year referred to, but was not adopted as an optional or alternate method until the following year.

At the convention of 1885 Dr. Wiley, as chairman of the potash committee, reported the results of some very valuable cooperative work on potash determinations carried out under the direction of that committee, and as a result of these investigations the use of hydrochloric acid as a solvent in potash work was discontinued, and the employment of oxalic acid or ammonium oxalate in connection with ammonia and ammonium carbonate was recommended, the second evaporation and ignition after the use of ammonium carbonate being dispensed with.

In 1886 the Lindo-Gladding method was subjected to comparative tests along with the official method, although only a small proportion of the analysts taking part in the potash work made determinations by the new process. The results presented, however, were quite satisfactory, and the Lindo-Gladding process was given a place as an alternate method, while the leading feature of this process was further recognized in the provision made in the official method for the use of ammonium chloride wash water in case of the contamination of precipitates obtained by what was then the regular method. The new method was given a further and quite comprehensive trial in 1887, and was adopted as the regular official method, while the former official process was relegated to the place of an alternate method.

The method of Lindo, as originally modified by Gladding, provided simply for the addition of ammonia before making solution up to the mark, but in 1888, upon recommendation of Mr. E. B. Voorhees, of the New Jersey Station, the addition of ammonium oxalate to effect the complete precipitation of lime was also required.

During the succeeding two years no changes of importance were made in the methods of potash determination, although in 1891 the process was so modified that ammonia was added before the ammonium oxalate in the official method, and the addition of the latter reagent was made to the hot solution instead of adding it to the solution after cooling. At this meeting of the association a paper was presented by Mr. A. L. Winton, of the Connecticut Station, with reference to the desirability of omitting the use of sodium chloride from the Lindo-Gladding method, and numerous results were reported in support of the contention that the employment of this substance was unnecessary. This question was further tested under the direction of Dr. G. F. Payne, reporter on potash for 1892, and as the result of numerous cooperative determinations the use of sodium chlorid was discontinued. As before stated the employment of sodium chloride was proposed by Gladding in his original modification of the method of Lindo, but the use of sodium chloride in the determination of potash in the presence of sulphates had been proposed by Wallace, Tatlock, and Clark as early as 1875. (Chem. News, 32, 202.)

At the 1891 meeting, the method for kainit was so changed as to require the use of ammonia and ammonium oxalate to precipitate lime, and an additional evaporation and ignition was thus entailed upon those employing this method. This change was made without any request therefor by the reporter, and without any previous investigation into the desirability of such a change. Some two years since, upon the recommendation of Mr. Winton, the referee on potash at that time, the association dispensed with the use of ammonia and ammonium oxalate, and returned to the use of the method as originally employed.

In 1893, for the first time, the cooperation of European chemists was secured in the determination of potash in association samples, but the results of this cooperative work were of comparatively little value, for the reason that the foreign chemists employed the German official methods and the Stassfurt method, while American chemists likewise confined themselves to the use of American official methods.

During the past few years Messrs. Wheeler and Winton, as referees on potash, have tested the accuracy of both the Lindo-Gladding and optional methods quite thoroughly by the employment of chemically pure potash salts, mixed with varying proportions of the impurities commonly met with in the crude potash salts. Cooperation on the part of German chemists was also secured to a limited extent in testing the comparative merits of the Lindo-Gladding and Stassfurt methods, and the Stassfurt method has also been given an official trial by this association, with results not at all disadvantageous to our present official method.

Winton has shown by results of experiments reported to the association that a very common source of error in potash determinations is the retention of mother liquor in the interior of crystals of the double chloride, especially when these crystals are at all large, and on this account has recommended that the drying be effected at 130° C., or else that the precipitation be effected from dilute solutions.

As the result of investigations made and reported some two years since, the factor now employed for the calculation of the amount of potassium oxide is 0.1939 instead of the factor 0.19308 formerly in use.

The abstract committee has furnished the association with information with regard to new methods of fertilizer analysis proposed by foreign workers, and it would be useless to refer in detail to the various processes proposed in the time elapsing since the résumé of potash methods was presented in the proceedings of the second annual convention.

The perchlorate method has attracted considerable attention from foreign chemists within the past few years, and in a recent number of the Journal of the American Chemical Society (January, 1899) Mr. F. S. Shiver presents the results of an investigation made by him with regard to the advantages of this process as compared with other methods.

The perchlorate method, however, is not a new method in principle, having been employed by Schloesing, Henry, and others nearly thirty years ago, though, by reason of certain improvements in the details of the process, it has become more easy of execution, and is held in high esteem in many of the European laboratories.

Numerous processes have been proposed by Borntraeger, Jean and Trillat, Ehrmann, Villiers, Borg, and others for the reduction of the chloro-platinate by means of various agents, the spongy platinum being weighed instead of the double chloride; but none of these processes seems to be free from objections with regard to its use as an independent method.

POTASH WORK FOR 1899.

The early date at which the association convenes this year and the large amount of work devolving upon the referee during the spring and early summer months have led to the contraction of the scope of the work on potash for the present year. Much to my regret, some features which it was intended should be included in the investigation of potash methods were, at the last, eliminated from the plan of work outlined for the present season and the work was restricted to limits commensurate with the time at the disposal of the referee and the cooperating chemists.

During the past spring a circular letter was sent out to about sixty laboratories with a view to securing cooperation on the part of the chemists addressed in the investigation of methods of potash determination. In reply to this letter twenty-five chemists requested samples, several of whom, however, agreed to do the work conditionally. The following letter of instructions was sent out with each set of samples:

Instructions for potash work for 1899.

In view of the fact that other features of the potash work have been covered quite fully during the past few years, it has been deemed desirable to prepare for distribution two samples which contain at least a portion of their potash in organic forms.

Sample No. 1 consists largely of acid phosphate mixed with ground tobacco stems, while an additional amount of potash is supplied as muriate. Sample No. 2 is composed chiefly of acid phosphate and cotton-seed meal, together with a small proportion of sulphate of potash.

The preparation of the solution for potash determinations should be effected according to the method usually employed for organic materials, 10 grams of the sample being saturated with strong sulphuric acid and thoroughly incinerated.

The referee would also suggest that parallel tests be made with employment of sulphuric acid diluted 1:1 (one to one) for saturation of the material preparatory to ignition. The acid thus diluted moistens the material much more thoroughly than a corresponding amount of the concentrated acid, and after drying the sample slightly on an asbestos board it can be quickly incinerated in a muffle or over the direct flame with less difficulty than where the strong acid is employed.

It is desired that results be reported both by the Lindo-Gladding and the optional methods, and the statement of results should show the amount of substance employed in the determination, the total weight of K_2PtCl_6 obtained, and the weight of K_2PtCl_6 from blanks.

It was suggested at the last meeting of the Association of Official Agricultural Chemists that all weighings by the Lindo-Gladding method should be made in the Gooch crucible, and it is requested that comparative tests of results by the use of the Gooch crucible and the tared filter be made (by the Lindo-Gladding method), the precipitate being dissolved on the filter paper with hot water in order to check results.

It is also desired that moisture in the samples be determined.

Results should reach the referee not less than fifteen days in advance of the next meeting of the association, in case said meeting is held in July, or thirty days in advance of the meeting, in case the convention is held in the fall.

Respectfully,

B. B. Ross, *Referee.*
L. S. Munson, *Associate.*

The two samples sent out for analysis were prepared as follows:

Sample No. 1 consisted of an intimate mixture of acid phosphate, finely ground tobacco stems, chemically pure potassium chlorid, and chemically pure magnesium sulphate, in the following proportions: 82 ounces of acid phosphate, 64 ounces of tobacco stems, 10 ounces of potassium chlorid, 4 ounces of magnesium sulphate.

Sample No. 2 was prepared by mixing the following ingredients in the proportions named: 84 ounces of acid phosphate, 64 ounces of cotton-seed meal, 8 ounces of potassium sulphate, 4 ounces of magnesium sulphate.

In both cases the constituents of the mixture were finely pulverized and intimately mixed with each other. Careful analyses made in the laboratory of the Alabama Station showed the tobacco stems to contain approximately 9.62 per cent potash, while the cotton-seed meal showed a content of 2.04 per cent potash. Calculated upon this basis, sample No. 1 should contain about 7.80 per cent potash, and sample No. 2 about 3.52 per cent potash.

Reports were received from seven laboratories exclusive of the Alabama laboratory, and the appended table of results represents the work of twelve analysts in eight laboratories.

Results upon sample No. 1.

Analyst.	Moisture.	Lindo-Gladding method.		Optional method.	
		Incineration with concentrated acid.	Incineration with dilute acid.	Incineration with concentrated acid.	Incineration with dilute acid.
W. A. Rawls, Florida	....	[1]7.77	7.75		
		[2]7.70			
		7.74			
Thorn Smith, Idaho	7.74	7.99	7.78		
		7.97	7.78		
			7.78		
		7.99			
		7.98			
		7.98			
		7.98			
R. E. Blouin, Louisiana	....	[2]7.85	[2]7.82	[2]7.80	[2]7.84
J. S. Carroll, Mississippi	6.32	7.90			
		7.94			
		7.85			
		7.88			
		7.89			
J. L. Stinson, Mississippi	6.32	7.84	7.90		
		7.87	7.92		
			7.91		
		7.85			
		7.82			
		7.84			
R. F. Hare, New Mexico	7.27	7.85	7.89	....	7.68
C. D. Harris, North Carolina	9.11	7.70	7.79		
		7.88	7.73		
		7.79			
			7.88		
			7.66		
			7.77		

[1] Used Gooch crucible.

[2] Used tared filter.

Results upon sample No. 1—Continued.

Analyst.	Moisture.	Lindo-Gladding method.		Optional method.	
		Incineration with concentrated acid.	Incineration with dilute acid.	Incineration with concentrated acid.	Incineration with dilute acid.
F. B. Carpenter, Virginia	...	7.78			
		7.80			
		7.79			
R. G. Newborne, Virginia	...	7.69			
J. Q. Burton, Alabama	8.23	...	7.88		
			7.95		
			7.91		
B. B. Ross, Alabama	...	...	[1]7.82	...	7.89
			[2]7.85		
			7.84		
Means	7.73	7.82	7.82	7.80	7.80

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[1] Used Gooch crucible.

[2] Used tared filter.

Calculated potash content, 7.80.

Results upon sample No. 2.

Analyst.	Moisture.	Lindo-Gladding method.		Optional method.	
		Incineration with concentrated acid.	Incineration with dilute acid.	Incineration with concentrated acid.	Incineration with dilute acid.
W. A. Rawles, Florida	...	[1]3.64	3.63		
		[2]3.65			
		3.64			
Thorn Smith, Idaho	7.92	3.56	3.41		
		3.56	3.41		
		3.56	3.41		
R. E. Blouin, Louisiana	...	[2]3.28	[2]3.29	[2]3.28	[2]3.30
J. S. Carroll, Mississippi	5.92	3.34	3.32		
		3.35	3.31		
		3.38	3.30		
		3.32	3.31		
		3.30			
		3.38			
		3.35			
J. L. Stinson, Mississippi	5.92	3.37	3.35		
		3.34	3.30		
		3.29	3.34		
		3.31	3.30		
		3.28	3.29		
		3.32	3.34		
			3.32		
R. F. Hare, New Mexico	4.75	3.61	3.74		
C. D. Harris, North Carolina	8.70	3.40	3.50		
		3.50	3.50		
		3.45	3.55		
			3.47		
			3.37		
			3.48		
F. B. Carpenter, Virginia	...	3.41			
		3.40			
		3.40			

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[1] Used Gooch crucible.

[2] Used tared filter.

Results upon sample No. 2—Continued.

Analyst.	Moisture.	Lindo-Gladding method.		Optional method.	
		Incineration with concentrated acid.	Incineration with dilute acid.	Incineration with concentrated acid.	Incineration with dilute acid.
R. G. Newborne, Virginia		3.42 3.41 3.41			
J. Q. Burton, Alabama			3.64 3.74 3.69		
C. L. Hare, Alabama	6.01		[1]3.62 [1]3.61 [2]3.55 [2]3.58 3.59		3.60 3.54 3.57
B. B. Ross, Alabama			[2]3.46 [2]3.51 3.48		3.38
Means	6.66	3.45	3.49	3.28	3.42

[1] Used Gooch crucible.

[2] Used tared filter.

Calculated potash content, 3.52.

COMMENTS OF ANALYSTS.

C. D. Harris, North Carolina.—All weighings were made in Gooch crucibles. I found that the time required for incineration was considerably shortened by using the 1 to 1 acid.

R. E. Blouin, Louisiana.—All weighings were made on balanced filters.

J. S. Carroll and J. L. Stinson, Mississippi.—In sample No. 1 low results were obtained when saturated with 5 or 6 cc dilute sulphuric acid, but good results when 10 cc were used. In sample No. 2, 5 cc of dilute acid seemed to be sufficient. All weighings were made in Gooch crucibles.

R. F. Hare, New Mexico.—I am of the opinion that the dilute acid is better than the concentrated for treatment of the material, and think that a strength of 1 to 4 would be better still.

C. W. McCurdy and *Thorn Smith, Idaho.*—Used paper in bottom of Gooch crucible instead of asbestus. The difference in the results with concentrated acid and 1 to 1 acid I ascribe to insufficient acid in the latter case. While the material was completely saturated, I do not think that there was a sufficiency of acid. We find the concentrated acid fully as easy to apply, and prefer it. There was a uniform loss of 0.01 per cent in dissolving off the precipitate and reweighing filter.

In the laboratory of the Alabama Station it was found that ignitions after saturation with 1 to 1 acid could be effected much more rapidly and easily than with the concentrated acid, and it is also easier to detach the ignited residue from the dish.

The data with regard to the comparative merits of the Gooch crucible and the tared filter, as derived from these results, are so meager as to preclude the drawing of any definite conclusions for or against the use of the filter. While a very large proportion of our analysts will probably prefer to use the Gooch crucible, nevertheless the results as reported by the use of tared filters indicate that it is possible to secure quite satisfactory results by the employment of the latter process of filtration.

The association has already recommended that the optional method be not used when the potash is present as sulphate, and it would seem that the same objection would hold good when the fertilizers are incinerated with sulphuric acid.

The referee has recently made a number of determinations by a process which is being tested in the Alabama Station laboratory, and it is his intention to make further trial of the method referred to with a view to determining its accuracy and adaptability to regular fertilizer work. A very large proportion of our mixed fertilizers requires ignition after treatment with sulphuric acid, and during the process of incineration not only is the organic matter destroyed, but ammonia is also expelled. This end having been attained, it is desirable if possible to avoid another evaporation and ignition. To obviate this second ignition the residue in the dish is removed without addition of hydrochloric acid, rubbed up with a pestle, and transferred to a beaker. It is next boiled with 300 cc of water, as usual, and just before the conclusion of the boiling a small quantity of barium carbonate, suspended in water, is added and the boiling continued for a short time. The barium carbonate effects the precipitation of iron, alumina, some of the phosphates, and a part of the lime and magnesia. The solution after cooling is made up to 500 cc, an aliquot is filtered out, a few drops of hydrochloric added, and then an excess of platinum chloride. The process is then continued as in the Lindo-Gladding mehod, using ammonium chloride wash water.

Results by this process agree quite closely, so far as the method has been tested, with those obtained by a water solution by the regular Lindo-Gladding method, but the method has so far been tried to only a very limited extent.

The referee would call attention to the fact that the results by the Lindo-Gladding method for sample No. 1, if one determination be excluded, are within 0.2 per cent of each other, and that, too, in a sample of a complex character, and with a potash content so high as to make a slight variation of little moment. These results bear strong testimony to tne accuracy attainable with the use of our present official method in case of complex mixtures containing potash derived from a number of different sources.

RECOMMENDATIONS.

The referee does not feel justified in recommending any changes in our present methods for potash determinations, but would suggest that the use of 1 to 1 sulphuric acid be allowed as an option for saturating mixed fertilizers preparatory to ignition.

The Chairman. Next in order is the report on phosphoric acid, by E. G. Runyan, of the U. S. Department of Agriculture, Washington, D. C. Before we have that, if there are suggestions to be made or discussion to be had upon the recommendations of the reporter on postash, they will be in order.

Mr. Wiley. I think it is a matter of congratulation that the referee finds his conscience will not permit him to make any suggestions for changes in the method of analysis.

The Chairman. We will take up the method for phosphoric acid, by Mr. E. G. Runyan, of Washington, D. C.

Mr. Runyan presented the following paper:

REPORT ON PHOSPHORIC ACID.

By E. G. Runyan, *Referee.*

In response to requests for samples from analysts who expressed a willingness to take part in the work on phosphoric acid for this year, sixteen sets of samples, with instructions, were sent out to as many analysts, but when the date of the meeting was announced it was feared that few of the analysts would have the work completed and ready to report by that time. Such proved to be the case, as the only reports received up to the present time are from two labaratories, which report results on part of the work outlined and state that lack of time prevented their doing more. Under the circumstances it was not thought best to present these few figures here, but to give instead a brief history of the work on phosphoric acid by members of this association since its organization, which has led to the adoption of our methods in their present form.

Realizing the urgent need of chemical methods which would yield more concordant results at the hands of different analysts, a meeting was called of American chemists engaged in fertilizer analyses, which convened in Washington July 28, 1880, and was styled a convention of agricultural chemists.

A committee of five was appointed to select a method for determining phosphoric acid in commercial fertilizers. This committee recommended the adoption, provisionally, of a method based on that of Fresenius, Neubauer, and Luek. By this method the water soluble was determined by rubbing up the sample with water and washing until filtrate was no longer acid. The citrate insoluble was determined by rubbing up residue from water soluble with 100 cc neutral ammonium citrate solution, transferring to flask, placing flask in cold-water bath, and raising temperature to 40°, maintaining at that point half an hour, filtering, and washing with dilute citrate solution.. The method for total was practically the same as the gravimetric method now in use.

At the Cincinnati meeting, in August, 1881, results obtained with phosphatic fertilizers by treatment according to the Washington method, and also results by the oxalate method were presented. In the general discussion the results by the Washington or citrate method were compared unfavorably to those by the oxalate method. The latter, it was claimed, gave higher available phosphoric acid.

After a lengthy discussion the convention decided to substitute ammonium oxalate for ammonium citrate as a solvent. By this method the insoluble was determined by treating the residue from the water soluble with 100 cc of a neutral solution of ammonium oxalate containing 20 grams of the salt to the liter, digesting in a boiling water bath for one hour, filtering, washing, and determining the insoluble in the residue by the usual method. This was known as the Cincinnati method.

Following this meeting a number of the chemists tested the Washington and Cincinnati methods on a set of samples sent out by the secretary. Strange to say, the results for available phosphoric acid by the oxalate were uniformly lower than by the citrate method. After these results were reported we find no further indorsements of the oxalate method, either by the convention of agricultural chemists or its successor, the Association of Official Agricultural Chemists.

At the Atlanta meeting, in May, 1884, a number of papers were presented giving results on the several forms of phosphoric acid according to the straight Washington method and modification thereof. These modifications were mostly variations in the temperature and time of treatment with citrate solution, and in the relative proportions of material and solvent.

The action of the convention in the adoption of a method for the ensuing year was practically a return to the Washington method, changing, however, the temperature of the bath used in the citrate digestion from 40° to 65°.

In September of the same year the convention of agricultural chemists met in Philadelphia and organized the Association of Official Agricultural Chemists.

The methods adopted by the convention at the Atlanta meeting were adopted as the official methods of the new association.

At the second annual meeting, in Washington, the following year, the committee presented averages of results obtained by fifteen analysts, with the highest and lowest results reported. A full discussion followed, but no important change in methods was made.

At the third annual meeting, in 1886, the committee reported results on soluble, insoluble, and total phosphoric acid. The results on total and soluble phosphoric acid were quite satisfactory, while the results on insoluble were extremely unsatisfactory.

Mr. Clifford Richardson presented a paper giving the results of some experiments in testing the delicacy of various indicators with ammonium citrate solution, and showed corallin to be more delicate than litmus for such work.

A paper was also presented giving results obtained in a comparison of Wagner's with the association method for the determination of available phosphoric acid. Wagner's method employs an acid solution of ammonium citrate.

The methods were changed to the extent of directing the use of corallin as an indicator in the preparation of the ammonium citrate solution.

In 1887 the committee on phosphoric acid presented results from only six analysts. While the results on the three forms of phosphoric acid were on the whole satisfactory, still the figures presented were considered too few to warrant making any changes in the methods.

In 1888 the committee presented results from thirty-two analysts. Some results were also contributed, obtained by experiments to test time required for complete precipitation. The figures given showed that in these tests the phosphoric acid was practically all precipitated by the molybdic solution in five minutes, and by the magnesia mixture in fifteen minutes.

One point brought out in the discussion which followed was that the variable quantity of water added each time to the phosphate in determination of soluble might be one cause of lack of uniformity. The association therefore directed that a Schleicher and Schüll No. 589 filter, 9 cm. in diameter, be used in the determination of water soluble, and that the phosphate be rubbed up in a beaker.

The methods were further slightly modified to the extent of allowing the use of either water or ammonium nitrate solution as a wash for the yellow precipitate.

The reporter in 1889 presented results from fifteen chemists. Most of these results were considered good. With each set of samples the reporter also sent 400 cc of ammonium citrate solution for comparison of tests for neutrality. One chemist reported this solution alkaline, while one reported it slightly acid.

The question of grinding and sifting the samples and size of sieve to be used came up for discussion, when it was found that wide differences existed in the practice of different laboratories. Therefore the association directed that the samples be passed through a sieve having circular perforations one twenty-fifth of an inch in diameter.

Following the report on phosphoric acid at the meeting in 1890, papers were presented emphasizing the facts that slight deviations from the neutral point of the citrate solution, variations in temperature, and relative proportions of material and solvent might cause wide differences in figures for citrate soluble, especially on phosphates of iron and alumina.

After an extended discussion the association modified the methods slightly by limiting the filtrate in the determination of water soluble to 250 cc and directing that the citrate insoluble residue be washed with water at 65°, instead of at ordinary temperature.

In 1891 the reporter gave considerable study to the action of various citrate solutions on phosphatic fertilizers, not only the official neutral solution, but acid and alkaline solutions as well.

In this connection he called attention to the fact that in working on fertilizers containing aluminum phosphate, some compounds containing phosphorus are either dissolved or carried through the paper when the citrate insoluble is washed with pure water, but when dilute citrate solution is used as the wash the filtrate is clear. It was suggested that in a case of this kind of material probably nearer correct results could be obtained by washing with cold, dilute citrate solution.

As a result of some experiments in the preparation of a neutral solution, the reporter presented a method which consists in the taking of a portion of the nearly neutral citrate solution prepared as usual and precipitating the citric acid with a neutral solution of calcium chlorid, filtering and testing neutrality of filtrate with cochineal. This was made an alternate method.

Early in the history of the association attention was called to the fact that with some classes of goods, especially cotton-seed meal, lower results were obtained when the organic matter was destroyed by a mixture of nitric and hydrochloric acids than when ignition was practiced.

Results obtained by trials of various methods on different fertilizing materials were presented at the meetings from time to time, and in 1891 much work was done along these lines and the data presented to the association. A thorough discussion followed and resulted in the adoption of the methods for oxidation of the organic matter and solution of the phosphate in practically their present form.

In 1893 the analysts were requested to determine insoluble by following strictly the official method, and also by modifying that method to the extent of heating the citrate solution to 65° before adding the phosphate. The results by the modified method were as a rule slightly lower, but they were much more concordant, and this modification was incorporated in the methods at the meeting in 1893.

At this meeting Prof. B. B. Ross gave a method for determining the citrate insoluble directly by destroying the organic matter in an aliquot portion of the ammonium citrate filtrate, preferably by digestion with sulphuric acid and mercuric oxid, and then proceeding as under determination of total phosphoric acid. The author gave a series of results obtained in his laboratory by this method, which showed close agreement with results determined by difference.

A comparison of this method with the official one was made by nearly all the analysts who took part in the phosphoric-acid work during the succeeding two years. The most of the results obtained were unsatisfactory.

While the results by the official gravimetric method were believed to be reliable, still the method is a long and tedious one, and analysts have long been looking for a method which would at least save one precipitation and at the same time give equally accurate results. To accomplish this various volumetric methods have been proposed, and in 1894 the reporter requested a trial of Pemberton's volumetric method, which depends upon the titration of the yellow ammonium-phospho-molybdate precipitate with a standard alkali solution. This method was later modified by Kilgore and also by McDonnell. Since 1894 an enormous amount of work has been done by members of this association in trials of this method and its various modifications.

The results at first obtained by many of the analysts were very discouraging, but later results were more concordant, and in 1895 they were considered promising enough to warrant the adoption of the Pemberton-Kilgore method as a provisional method. Further trials of this method were made and the results reported from year to year, and in 1898 the method was made an optional one.

A trial was made in 1896 and also in 1897 of Gladding's method of weighing the yellow precipitate, but the results reported by the members of this association did not show it to have any advantages over others already in use.

In anticipation of the sale in this country of large quantities of basic slags, members of this association have from time to time presented the results of their efforts in seeking a method for determining the available phosphoric acid in such material.

Of the many methods and solvents used in these trials, Wagner's method seems to be the only one that will give uniformly concordant results.

Interest in this work, however, seems to have declined lately, due largely to the small amount of this material which has found a sale in this country.

It has been claimed that the official gravimetric method gave too high results, due to excess of magnesia carried down by the ammonium-magnesium phosphate precipitate, and it was proposed to avoid this error by using a magnesia mixture containing citric acid in place of ammonium chlorid, or by adding ammonium citrate to the phosphate solution.

Trials were made of the proposed method in 1895 and in 1896. While the results were, as a rule, slightly lower than by the official gravimetric method, the proposed method was not considered to have any advantage over the official gravimetric method, especially as under some conditions the phosphate did not seem to be all precipitated.

Methods for the determination of iron and alumina have received the attention of this association, and results obtained by nearly all the latest methods have been presented at the meetings at various times, but up to the present none of the methods has been considered of sufficient merit to be indorsed as official.

It has been impossible, if advisable, in this review to mention all the papers and results on phosphoric acid presented at the meetings of this association, but it has been our aim to refer, however slightly, to all work which had a direct bearing upon a change or proposed change in the official methods for phosphoric acid.

Mr. WILEY. I would suggest that we have our meeting to-morrow morning after the general meeting of the association is finished, which will probably be about half-past 10. Therefore I move that we meet in this room to-morrow morning at half-past 10, and that the next meeting be held to-morrow immediately on the adjournment of the section on agriculture, so that we will have two meetings to-morrow. (Carried.)

Mr. KILGORE. I have a short paper on phosphoric acid, but I had no idea it would come up this afternoon. Moreover, the referee did not give us any results or recommendations. It might be well to get the opinions of men who report results as to how satisfactory the results were. At least one thing expected was the result of the comparison of the two methods.

Mr. RUNYAN. I am not prepared to give the exact figures sent in, but I received a report from Mr. Kilgore's station, and the only other figures received were from a commercial chemist, giving phosphoric acid on two samples, I think; so that I thought it hardly worth while to give them, and have not those figures with me.

Mr. KILGORE. I can give, in a very few words, the substance of the paper. Last year, in my report as referee on phosphoric acid, I took up the method of precipitation by shaking and did quite a good deal of work in that way. The main trouble, it seemed, that we had had with the volumetric method was that some of the nitric acid would be precipitated, and I tried various methods, as others had done, of preventing this, and while the method had given satisfactory results, still if we could precipitate in the cold I felt there would be no trouble, and, going back to the method of shaking as they do, we tried the shaking machine and found that precipitation was complete in all cases in fifteen minutes, though we let the machine run half an hour. As I say, we did quite a good deal of work last year in this line, and our results were all good. This year we have continued that again, and quite a large amount of work has been done in my laboratory by two or three men with shaking, and our results have all been good. In fact, in using the method in the future I think that shall be my procedure entirely. Now, we have not tried the shaking at a very low temperature, as some of you have, in the winter. Most of our work has been done in the spring or summer in a laboratory with a temperature of 20° to 30°, and our results that way have all been good. When a very large excess of molybdic solution is used you may get good results. We find we can not add a very large excess of molybdic solution without raising the results. The paper I had was upon this point. The paper I sent in was by both methods. We had also a large number of additional results.

Mr. Scovell. In the investigation of the volumetric method of analysis of phosphoric acid it has been my practice to add the phosphoric acid solution to the molybdic solution, then allow the mixture to stand at the temperature of the room from fifteen to thirty minutes before filtering. By this procedure the precipitate comes down in granular form, allowing a rapid filtration and obtaining a perfectly clear filtrate. Furthermore, our results indicate that by this method we may be able to obtain a precipitate of uniform composition—a condition which must obtain in order to have trustworthy results by the volumetric method.

In the meeting in Washington in 1897 I mentioned the possibility of an improvement in the method by the above procedure.

Mr. Wiley. Mr. President, it is rather strange that the mechanical method of shaking has not generally been brought into chemical work, because the principle seems to be so patent. You have in solution a substance which is diffused finely throughout the whole mass, and if crystallization takes place without motion it can only do so, first, by the solidification of the particles at a certain point, and then the gradual growth of the crystals. The theory of the movement is that the particles of matter, when formed, are at once brought into contact with the rest of the uncrystallized solution, so that they have a mechanical opportunity of precipitation. Now, that matter in technical work has been understood and acted upon—for instance, in the sugar industry. You know that in the sugar industry the first crystallizations are always secured in movement, because the movement of the boiling in the pan brings that about, and we get there magnificent crystallization. The old way in boiling molasses was to set the pans aside, sometimes for months, and to secure the crystallization, but now mechanical movement has been introduced, and a much larger crystallization is obtained. The molasses is kept in constant motion, and the result is the yield is far greater in a few hours or a day or two than before in weeks and months. The shaking secures a much more perfect separation, and I doubt not that a great many of our chemical operations could be greatly accelerated by applying this natural method. We ought not to allow the technicists to get ahead of us in our work.

I would like to announce that our next meeting will take place as soon as possible after the discussion of the "teaching of agriculture" in the general session of the American Association of Agricultural Colleges and Experiment Stations is finished, when we should at once repair to this hall and continue our work.

Adjourned.

SECOND DAY'S PROCEEDINGS.

The chairman (Mr. Kedzie) called the session to order, and stated that the first business would be the report of the referee on soils and ash, Mr. Hartwell, of Rhode Island.

Mr. Williams, of North Carolina, requested that the discussion on phosphoric acid, or papers upon that subject, be continued at this time, and the chair so directed.

Mr. Williams. I wish to state the results of our experiments. It was found that occasionally a fertilizer was encountered which was not dissolved by the usual method—that is, 30 cc nitric acid and 10 cc hydrochloric acid. It was found that in the solution it was not all dissolved. This was discovered by making determinations from the same solution one day, and a day or so after making the determination again, and it was found that the percentage of variance was considerable. We have found a difference as high as 5 per cent in the determination of phosphoric acid. In two samples worked on we worked for a number of hours. That is, we made the determination as soon as we could cool the sample—thirty-five minutes; and twenty-one hours after that we made another determination and got something like 5 per cent. In all these samples it was found that we had a large percentage of iron or aluminum. In two of the samples the percentage of ferric oxid was found as high as 19 and 24. We feel that this is very important, not only from the analytical standpoint, but from the practical standpoint. We see that in North Carolina the use of iron aluminum phosphates is coming into practice, and we see that we have a condition there that we must investigate.

The Chairman. Is there any other paper to be read or discussion desired on phosphoric acid?

Mr. Kilgore. I would like to ask if Mr. Williams tried hydrochloric acid alone for the solution. It appears that the trouble has come from making the solution in nitric acid. Apparently he has iron or aluminum phosphate to deal with, and I would like to ask what is the difficulty—whether he could not use the hydrochloric acid alone, which is one of our methods, recognized as the principal solvent in such cases. Last year, I know, in sending out slags as referee on phosphoric acid, some of the workers misunderstood the method indicated to be used, and tried this method Mr. Williams has employed, of using nitric and hydrochloric acid, and they had the same difficulty he has referred to.

The same question has come up again this year in regard to some of the other samples sent out. I know in my own laboratory they got the idea that nitric and hydrochloric acid were to be used as the solvent, and they could not get concordant results, and they thought that on aluminum goods, by their way, no trouble was had in getting everything into solution. Perhaps Mr. Williams will answer that question.

Mr. Williams. I found that with hydrochloric acid as a solvent complete solution was made. I also found that in two samples sent out this year the reporter said "use A_5." I found that hydrochloric acid alone effected a complete solution, but that if you made duplicate weighings and added to each of those 30 cc hydrochloric acid, boiled them forty minutes, and then added 30 cc nitric acid and continued the boiling, the difference obtained by those two methods would be something like 3 per cent.

Mr. H. K. Miller. I think there is a weak point just here in our methods. It is quite well understood that different fertilizing materials require different solvents. As methods are now we have the option of applying any of these methods of solution to a fertilizer. I think the matter should be thoroughly investigated, and an indication made as to which method of solution should be applied to the kind of fertilizers we are dealing with. Now recently, at the North Carolina Experiment Station, as Mr. Williams stated, there were quite a number of phosphates that came in, which, when treated by the regular method that was in common use there—that is, the nitric and hydrochloric acid, giving excess to the nitric—were not dissolved, but in the other case practically all the phosphoric acid was obtained. If we are to have these fertilizers of different sources I think we should endeavor to see what form of solvent or what form of solution we should have. I notice in working with this material containing iron and aluminum phosphates that in employing our usual method there—nitric acid with a small quantity of hydrochloric—when incomplete solution was made, there was a blue cast to the solution when diluted, but if hydrochloric was used alone, or with only a small quantity of nitric acid, a colorless solution was obtained. I think the matter should be investigated, and different kinds of fertilizers should have different kinds of solvents.

Mr. Jenkins. It seems to me that in matters of sampling fertilizers and getting your original solution, while specific directions are very helpful to all of us, they can not take the place of individual judgment. Whatever the method—however thoroughly it has been worked out—this method of solution, when you strike a new kind of phosphatic matter—those methods ought not by anyone to be depended on as final and as giving a correct result. It seems to me when a man makes a solution of a fertilizer he is familiar with, he is bound to satisfy himself that it is dissolved, and he can not be certain about it until he has demonstrated to his own satisfaction that the method he uses will give the solution. Nothing can take the place of individual judgment and great care in using the method. I would never undertake to examine a class of phosphatic materials with which I was not absolutely familiar in everyday work, without testing my residues before going further, to see whether the method I was using was absolutely certain to give me a perfect solution. Now, if hydrochloric acid acting on phosphate needs more time let it have it; but you have got to use individual judgment.

Mr. Kilgore. In the line of what Dr. Jenkins says, and in reply to the gentleman inquiring about the methods, I would say that this subject has been very thoroughly investigated by this association. A number of years ago the question of solvents for different fertilizing materials came up. Some of us will remember away back about six years ago when aluminum phosphate in a pure or apparently pure form, containing 40 or 45 per cent, was sent out, and it was difficult to get a solution of this material. Now, when we used nitric and hydrochloric we could not get it. The aluminum phosphate referred to by Mr. Williams, of the North Carolina Station—you can always tell when the material is present in a fertilizer in any quantity by the color of the solution. It does not go into solution readily, and the residue when shaken up gives you that rather pink cast. You can always tell when it is present by that means.

Mr. Wiley. There is a gentleman here, Mr. J. A. Pitcher, representing the State Board of Trade, who would like to extend an invitation to this association.

Mr. Pitcher. Representing the State Board of Trade, which maintains in San Francisco a permanent exhibit of the products of California, I take the liberty, on behalf of the board, to extend you a cordial invitation to view the exhibit. If you could come in a body some afternoon and spend an hour with us, I believe you would agree with us that we have one of the attractions of the city. You would be interested in seeing our samples of what California produces, and in our mining bureau you can find samples of all the minerals in the United States. You will be very welcome, indeed, at any time.

On motion, the invitation was accepted with thanks.

Mr. Wiley. Again I would like to interrupt the regular order, for this reason, that we have had no committee on hour of meeting, because our meetings are a little irregular; but I want to make the statement that for to-morrow afternoon the association has accepted an invitation to attend a reception at the hotel, and I have no doubt that our members who are also members of the other association would like to attend. I therefore propose that we set 10 o'clock to-morrow morning for the meeting, and I make the motion that when we adjourn it be to meet at that time in this room.

The motion was agreed to.

Mr. Hartwell read the following paper:

REPORT ON SOILS AND ASH.

By Burt L. Hartwell. *Referee.*

Contrary to the expressed idea of this association that a referee should hold his position for at least two years, my predecessor, through some misunderstanding, was relieved of his responsibilities in this connection at the end of a single year. As associate referee, the writer was appointed to attend to the duties of referee at least a year earlier than was expected or desirable.

It being already too late to obtain soil from our colder climates, it was deemed advisable, under the circumstances, to secure additonal data concerning some of the soils having the most definite history, which had been worked upon, and to introduce fertile soil from California for the sake of comparison with results already secured from more eastern sections.

My associate was unfortunately separated from me by the width of a continent, and it was January before we could by correspondence decide upon the work to be undertaken. The following circular letter was then sent to the experiment station chemists:

Kingston, R. I., *January 23, 1899.*

Dear Sir: The Association of Official Agricultural Chemists recommended that the work on soil for 1899 include (1) a trial of the so-called international method for determining assimilable potash, i. e. using dilute nitric acid as a solvent (fifth-normal acid will be recommended); (2) a further trial of Höllemann's method for the determination of the active lime compounds, i. e., using water saturated with carbonic acid; (3) further tests with alkaline ammonium chlorid as a solvent for potash; a continued use of calcium chlorid in this connection was considered inadvisable. It seems desirable, in addition to the above, to determine the amount of phosphoric acid in the extract obtained by using the dilute nitric acid mentioned above; to test dilute acetic acid as a solvent for active lime compounds, as well as the carbonated water; to try the efficiency of fifth-normal nitric acid in determining assimilable phosphoric acid, alongside of fifth-normal hydrochloric acid which has been adopted provisionally, inasmuch as the nitric acid is to be tested as a solvent for potash; to further investigate the solvent action of citric acid upon potash and phosphoric acid before discarding entirely this solvent which has given satisfactory results in the hands of so many; and to determine total humus by the official method.

In view of the difficulties which have been encountered in determining silica and potash in ashes, a mixture containing a known amount of these ingredients in the form of silicate of potash, and such other elements as are ordinarily present in ashes, will be distributed to chemists participating in the work. By this means correct indications should be secured as to the efficiency of the method in finding the actual amounts of potash and silica present where there is a large amount of other ingredients.

In order to prosecute the various lines of work upon soils, samples of known and different characteristics should be secured. Certain soils are now in readiness for the work, but as it is desirable to obtain the best available ones, your assistance is solicited in obtaining soils answering the following requirements, viz: (1) Deficient in assimilable potash; (2) deficient in assimilable phosphoric acid; (3) deficient in assimilable nitrogen; (4) deficient in "active" carbonate of lime; (5) containing an abundance of one or more of the above ingredients.

Unfertilized soils are the most desirable, but in case of a soil most lacking in one ingredient it would not be debarred from use even though the other essential ingredients had been added.

The degree of exhaustion of the soils must have been established by soil tests, otherwise the value of a given solvent can not be ascertained.

The soil should contain no exceptional ingredients interfering with its productiveness nor be in need of special treatment to insure good crops, other than an application of the particular elements in which it is claimed to be deficient.

If such soils are not available at present, please report them so that they may be in readiness for future work.

It can hardly be expected that any chemist will be able to undertake all the work outlined, but that certain phases of it will appeal with special interest to different ones. The most valuable results are often secured by chemists working with the soils distributed upon problems not outlined by the referee, and it is hoped that papers embodying such results may be presented at the next meeting.

Your cooperation is earnestly desired. Please state definitely at your earliest convenience what portion of the work you will try to undertake that suitable samples and directions may be sent you. Suggestions from you will be highly appreciated concerning the problems in hand.

Very respectfully,

BURT L. HARTWELL, *Referee.*
M. E. JAFFA, *Associate.*

DIRECTIONS FOR WORK ON ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS' SOIL SAMPLES FOR 1899.

(1) DETERMINATION OF MOISTURE.

Use the official method described in Bulletin 46, page 38, Division of Chemistry, U. S. Department of Agriculture.

(2) DETERMINATION OF PHOSPHORIC ACID SOLUBLE IN FIFTH NORMAL HYDROCHLORIC ACID.

(*a*) *Preliminary treatment.*—Digest 20 grams of soil with 200 cc of fifth-normal HCl in a water bath at 40° for five hours, shaking every half hour. Titrate 20 cc of the clear filtrate against a standard potassium hydroxid solution, using phenolphthalein for the indicator. From the data thus secured calculate the amount of HCl necessary to be added, so that the solution will be fifth-normal after allowing for the acid neutralized.

(*b*) *The determination.*—2,000 to 3,000 cc of acid, corrected for neutralization, as directed under (*a*), are heated in a stoppered receptacle to 40°. Ten grams of soil for every 100 cc of acid are now added and the digestion continued at this temperature for five hours, shaking thoroughly every half hour. The contents are then shaken and filtered through a dry, ribbed filter of two thicknesses of paper and of sufficient size to receive the entire contents, refiltering the first portion of the filtrate if cloudy. A definite volume, comprising nearly all the filtrate, is taken at the temperature at which the original acid was measured, and evaporated to dryness after adding 1 to 3 cc of nitric acid. If there is an appreciable amount of organic matter present ignite the residue carefully, digest with HCl and water, filter, neutralize with ammonia, and 5 cc strong nitric acid and 15 grams of ammonium nitrate. Complete the determination according to one of the official methods.

(3) DETERMINATION OF PHOSPHORIC ACID AND POTASH SOLUBLE IN FIFTH-NORMAL NITRIC ACID.

Proceed with the preliminary treatment similarly as under 2 (*a*), and with the digestion and filtration as under 2 (*b*). Take two definite portions of the filtrate. Use one portion for determining phosphoric acid similarly as in section 2. Evaporate the other portion to a small volume in a porcelain dish, transfer to a platinum dish, add a little sulphuric acid and determine the potash by the Lindo-Gladding method.

In the case of the deficient soils, Nos. 1 and 2, nearly all the filtrate should be used for the single determination.

(4) DETERMINATION OF LIME SOLUBLE IN DECINORMAL ACETIC ACID.

Proceed with the preliminary treatment similarly as under 2 (*a*), and with the digestion and filtration as under 2 (*b*), using from 100 to 200 grams of soil, according to the apparent amount of calcium carbonate present. Evaporate a definite volume comprising nearly all the filtrate, after adding a little HCl to a small volume in a porcelain dish, transfer to a platinum dish, ignite, dissolve in HCl and water, filter, continue with the determination of calcium and the necessary previous separations according to the ash and soil methods, Bulletin 46, pages 40 and 44, Division of Chemistry, U. S. Department of Agriculture. (In the case of soil No. 3 the preliminary treatment will not be necessary; a little manganese will probably be dissolved both by this solvent and the carbonated water.)

(5) DETERMINATION OF LIME SOLUBLE IN CARBONATED WATER.

To from 100 to 200 grams of soil, according to the apparent amount of calcium carbonate present, add for every gram of soil taken, 10 cc of water saturated with pure carbon dioxid. The receptacle in which the digestion is carried out should be provided with a rubber stopper containing two holes sufficiently large to admit easily two glass tubes, each of which shall be closed at the lower end and have a perforation blown in it about 1 inch from that end.

After supplying the acid and soil, adjust the tubes as illustrated, open the pinch cock C, replace the air above the liquid by allowing a current of carbon dioxid to pass through until the escaping gas can be entirely absorbed by caustic alkali. Raise the tubes until the perforations are closed by the stopper, shake vigorously for half a minute, push in the tubes again, and equalize the pressure by allowing carbon dioxid to pass in through A or out through B acccording to circumstances, taking care that no air is admitted, as this would decrease the amount of carbon dioxid in the solvent. Repeat the shaking and venting, as above, nine times at about equal intervals during the working day. At the end of three days filter as usual. Take a definite volume, including nearly all the filtrate, add hydrocholric acid, evaporate to dryness, ignite if necessary, dissolve in hydrochloric acid and water, filter, and determine calcium as in section 5. Verify the saturation of the carbon dioxid water before using by adding to a definite volume an excess of baryta or lime water of known strength and determining that excess by titrating a portion of the clear solution against standard acid. (See Sutton's Volumetric Analysis 7th ed., p. 96.)

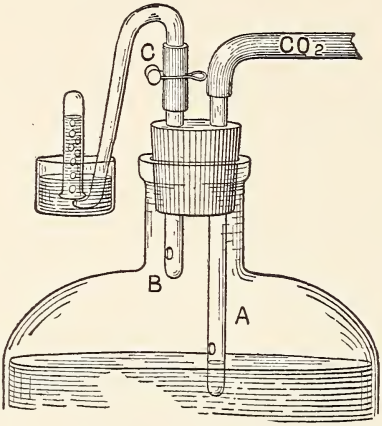

Fig. 1. Apparatus for determination of lime soluble in carbonated water.

(6) Determination of Humus.

Pass a portion of the soil through a 5-mm. sieve, pulverizing if necessary, and determine the humus by the official method, Bulletin 46, page 42. In the case of difficulty in filtering the ammoniacal solution, a large Buchner filter, under pressure, has been successfully employed.

(7) Determination of Potash Soluble in Ammonium Chlorid.

Make up a twentieth-normal solution of ammonium hydrate by titrating against standard acid, using cochineal as an indicator, and dissolve 17.2 grams of c. p. crystalline ammonium chlorid in each liter of the same. Digest the soil with this solvent and filter as under 2 (*b*). Evaporate a definite portion of the fitrate to a small volume in a porcelain dish, transfer to a platinum dish, and determine the potash by the Lindo-Gladding method.

(8) Determination of Phosphoric Acid and Potash Soluble in Citric Acid.

Chemists wishing to test the solvent action of citric acid should use fifth-normal acid, following the same general directions for preliminary treatment, digestion, and filtration as given under section 2. The citric acid solution should be used soon after making, as it is liable to ferment. The method outlined in Bulletin 49, pages 81 and 82, of the Division of Chemistry, may be followed for the subsequent treatment.

Blank tests must be made in the potash determination at least, using the same amounts of solvent and reagents as employed when the soil is taken, and the average results reported. Report results as soon as the work is completed; it should not be later than June 15, as the association may meet early in July. Calculate the percentages on a water-free basis to the fourth decimal place. The individual determinations rather than the averages should be furnished, after deducting the appropriate blanks.

DESCRIPTION OF SOILS AND DETERMINATIONS TO BE MADE.

No. 1. From Junction City, Ky.—This is the same soil as distributed by the referee for last year as No. 1. It is deficient in available phosphoric acid. The determination of phosphoric acid soluble in fifth-normal nitric acid is desired for comparing with the results secured last year with fifth-normal hydrochloric acid. Three results were reported last year on the amount of phosphoric acid dissolved from this soil by 1 per cent citric acid at room temperature.

No. 2. From the Kentucky Agricultural Experiment Station.—This is the same as distributed by the referee for last year as No. 2. It is deficient in available potash. The determination of potash soluble in fifth-normal nitric acid is desired. A few widely varying determinations of the amount of potash dissolved by ammonium chlorid were reported last year. Additional determinations, using larger amounts of soil and the stronger ammonium chlorid recommended this year at the suggestion of Mr. Huston, who first used it, are solicited from chemists wishing to work with this solvent.

No. 3. From the Rhode Island Experiment Station.—This soil is deficient in available lime, and gives an acid reaction to litmus paper. Determinations of humus and of lime soluble in acetic acid and carbonated water are desired.

No. 4. From Ventura, Cal.—A good representative of the arid upland or bench soils.

No. 5. From Arlington Heights, Southern California.—A soil similar in texture to the eastern loams. Nos. 4 and 5 are abundantly supplied with plant food, and it should be noted in this connection that they contain from 1 to 1.5 per cent of lime. The determinations outlined in sections 3, 4, and 5 are particularly needed for comparison with the soils deficient in plant food. Determine humus in No. 4. The dissolving action of fifth-normal hydrochloric acid, which was adopted provisionally as a solvent for available phosphoric acid, could be well studied upon these soils. The soils are also adapted for further work with citric acid and ammonium chlorid upon fertile soils by chemists wishing to furnish results with these solvents for comparison with what have already been obtained by their use upon other samples.

Nos. 1 and 3 are to be forwarded by A. M. Peter, Lexington, Ky.; Nos. 4 and 5 by M. E. Jaffa, Berkeley, Cal., and No. 3 by Burt L. Hartwell, Kingston, R. I.

BURT L. HARTWELL, *Referee.*
M. E. JAFFA, *Associate.*

KINGSTON, R. I., *March 20, 1899.*

There was so little demand for the ash sample that it was decided to confine the work to the soil samples. Thirteen chemists expressed a willingness to undertake, to a greater or less extent, the soil analysis, and in March the directions for this work were furnished. The chemists were urged to report their results by June 15, in view of the possible early meeting of the association in July. Considerable difficulty was encountered in securing the distribution of certain of the soils, and only a portion of the samples were placed in the hands of the chemists at the time they received the directions.

So few results had been received at the time of writing this report that it was considered wise to request the cooperating chemists to finish the work as soon as time permits, with an idea of embodying it in the report of the referee for the coming year, and to defer until then the publication of the directions which were distributed.

In accordance with the suggestion of our secretary and my own inclinations, an attempt has been made to take a comprehensive glance at the work of the past few years, especially as the results in connection with the present year's work will not be considered at this time.

In 1895 A. M. Peter, the referee for that year, inaugurated a line of work upon soils new to the association. It consisted of a trial of dilute solutions of salts, acids, or their combination, as to their ability to indicate the relative amounts of the more active forms of plant food within the soil in a more satisfactory manner than the stronger solvents previously employed. Since that time various solvents have been recommended for trial by the succeeding referees. In order to discuss intelligently the action of a given solvent upon different soils it becomes necessary to have at hand all the available data possible concerning not only their chemical composition but their geological formation, physical characteristics, crop-producing power, and history. Some of the referees have included in their reports apparently all the facts which were obtainable at the time bearing upon the results. Others, however, have included only very meager descriptions of the soils used. It is very important, in view of the short tenure of office, that each referee include in his report all information which may in the future be of service when the work of a series of years is viewed in its entirety, and which will enable succeeding referees to trace the connection between one year's work and another.

The writer has attempted to compile in a concise form the average results which have been secured on some of the soils with more or less complete records, and upon which considerable work has been done, especially where it has been possible to supplement by new data those heretofore published in the proceedings. These abstracts, as far as the chemical work is concerned, should be compared with the more complete reports containing individual determinations, if one wishes to study closely the records, but it is hoped they will bring the detached results into such form that they will present a more organized appearance, and prove of assistance to anyone taking up this line of investigation.

Unless otherwise stated, the percentages represent the average results secured by a number of chemists, cooperating under the direction of the referee.

SOIL FROM THE EXPERIMENT STATION FARM AT LEXINGTON, KY.

Derived from Lower Silurian limestone, rich in phosphoric acid. Top soil a brown clayey loam; subsoil a yellow clay, so retentive as to cause the land to be deficient in natural drainage; surface soil 8 to 12 inches deep, but the samples were taken 6 inches deep. Cultivated for many years previous to 1888, probably without addition of stable manure or other fertilizer.

In 1888 an experiment was begun with maize, which should indicate the relative amounts of available nitrogen, phosphoric acid, and potash within the soil. Acid phosphate, muriate of potash, and nitrate of soda in amounts furnishing about 57 pounds of available phosphoric acid, 80 pounds of potash, and 26 pounds of nitrogen, respectively, were used per acre each year.

Yields of ear corn per acre, in bushels.

(Acre plots.)

No. of plot.	Fertilizers supplied.	1888.	1889.	1890.	1891.	1892.	1894.	1895.	1896.	[1]1897.
2	None	27	31	40	44	38	13	29	20	10
3	N, P_2O_5, K_2O	63	84	72	56	61	35	57	58	40
4	P_2O_5, K_2O	70	81	65	51	51	30	46	42	32
5	N, P_2O_5	29	35	33	43	29	15	36	24	16
6	K_2O, N	60	87	76	60	62	35	55	42	44
7	None	32	34	34	39	27	15	33	20	14
8	K_2O	....	79	67	54	52	30	45	42	33
9	P_2O_5	....	33	36	38	25	13	30	21	14
10	N	....	41	35	40	27	18	36	28	17

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[1] The last year of the experiment. The records for 1893 were destroyed by fire.

Mechanical analysis of the soil from plots 5 and 6.

[1895 Proceedings.]

Made under the direction of Milton Whitney, who remarks: "It has the same texture as our corn and wheat lands, being, in fact, rather light for profitable wheat production."

	Per cent.		Per cent.
Moisture in air-dried sample	2. 24	Fine sand, 0.25–0.1 mm	1. 26
Organic matter	6. 60	Very fine sand, 0.1–0.05 mm	5. 28
Gravel, 2–1 mm	1. 96	Silt, 0.05–0.01 mm	45. 63
Coarse sand, 1–0. 5 mm	3. 40	Fine silt, 0.01–0.005 mm	13. 54
Medium sand, 0.5–0.25 mm	2. 69	Clay, 0.005–0.0001 mm	17. 67

Chemical analysis of air-dried fine soil from an unfertilized plot.

[1894 Proceedings, A. O. A. C.—Provisional method.]

	Per cent.		Per cent.
Insoluble matter	80. 520	P_2O_5	. 418
K_2O	. 422	N	. 190
CaO	. 379	Moisture	1. 941
MgO	. 381	Ash from humus	2. 170
Fe_2O_3	3. 251	P_2O_5 in humus ash	. 170
Al_2O_3	6. 191		

4.33 per cent of the original soil failed to pass the 0.5 mm. sieve. This iron gravel or "shot iron ore" contained 2.117 per cent P_2O_5, and if it had been included with the fine soil would have materially increased the Fe_2O_3 and P_2O_5. The latter, in a soil passing 1 mm. sieve, would have been increased to 0.502 per cent.

By digesting 10 grams of the fine soil in 100 cc normal oxalic acid six hours at 100°, J. H. Kastle and others removed as much P_2O_5 and about half as much K_2O as by the provisional method.

K_2O and P_2O_5 dissolved in digestion of fine soil (calculated to water-free basis).

[Soils from experiment-station farm, Lexington, Ky.]

Plot.	Solvent.	Cubic centimeters solvent to 1 gram soil.	Time of digestion.	Temperature of digestion.	Per cent of P_2O_5.	Per cent of K_2O.
	Frequent shaking by hand.					
2[1]	N/5 hydrochloric acid	100	5 hours	40° C.	....	0. 012
2	N/5 calcium chlorid	100	5 hours	40° C.	....	. 005
2	N/5 citric acid	100	5 hours	40° C.	....	. 007
2	Ammonium citrate (fert. sol., 1 in 10)	100	5 hours	40° C.	....	. 007
2	N/5 oxalic acid	100	5 hours	40° C.	....	. 009
2	Ammonium oxalate (16 grams per liter)	100	5 hours	40° C.	....	. 012
7[2]	N/5 calcium chlorid	100	5 hours	40° C.	....	. 006
7	Ammonium chlorid (10.68 grams per liter) of N/20 NH_4HO.	100	5 hours	40° C.	....	. 0104
5[3]	Citric acid (10 grams per liter)	50	5 hours	Room	0. 0268	. 0039
6[3]	.....do	50	5 hours	Room	. 0235	. 0050
5	Ammonium oxalate 40 grams, acetic acid 2.15 grams, per liter.	50	5 hours	Room	. 0733	. 0060
6	.....do	50	5 hours	Room	. 0661	. 0113

[1] Proceedings A. O. A. C., 1896.

[2] Proceedings A. O. A. C., 1898; samp. taken Mar., 1898.

[3] Proceedings A. O. A. C., 1895; samp. taken Nov., 1894.

K_2O and P_2O_5 dissolved in digestion of fine soil (calculated to water-free basis)—Continued.

[Soils from experiment-station farm, Lexington, Ky.]

Plot.	Solvent.	Cubic centimeters solvent to 1 gram soil.	Time of digestion.	Temperature of digestion.	Per cent of P_2O_5.	Per cent of K_2O.
	Frequent shaking by hand.					
5	Oxalic acid (6.3 grams per liter)	50	5 hours	Room	.0562	.0060
6	.....do	50	5 hours	Room	.0575	.0074
5	Oxalic acid (1 per cent sol.)	50	5 hours	Room	.1100	....
6	.....do	50	5 hours	Room	10.40	....
5	Oxalic acid (equivalent to 1 per cent citric)	50	2 hours	Room	.1135	.0040
6	.....do	50	2 hours	Room	.1062	.0087
5	Acid potassium oxalate (equivalent to 1 per cent citric).	50	2 hours	Room	.1067	....
6	.....do	50	2 hours	Room	.0976	....
5	Acetic acid (equivalent to 1 per cent citric)	50	2 hours	Room	.0014	.0013
6	.....do	50	2 hours	Room	.0017	.0043
5	Citric acid (10 grams per liter)	50	7 days	Room	.0560	.0038
6	.....do	50	7 days	Room	.0511	.0069
5	Total by hydrofluoric acid	....	....	....	....	1.105
6	.....do	....	....	....	....	1.147
	Constant shaking by machine.					
5[1]	Ammonium oxalate 40 grams, acetic acid 2.15 grams, per liter.	50	5 hours.	Room	.0776	.0183
6[1]	.....do	50	5 hours.	Room	.0625	.0189
5	Ammonium oxalate 40 grams, ammonia equivalent to 2.15 grams acetic acid, per liter.	50	5 hours.	Room	.0165	.0144
6	.....do	50	5 hours.	Room	.0138	.0226
5	Ammonium chlorid 17.2 grams, ammonia equivalent to 2.15 grams acetic acid, per liter.	50	5 hours.	Room	.0	.0134
6	.....do	50	5 hours.	Room	.0	.0176
5	Ammonium chlorid 17.2 grams per liter	50	5 hours.	Room	.0	.0218
6	.....do	50	5 hours.	Room	.0	.0238
5	Ammonium chlorid 17.2 grams, ammonia 0.96 specific gravity 1 liter.	50	5 hours.	Room	.0	.0137
6	.....do	50	5 hours.	Room	.0	.0162
5	Ammonia 0.96 specific gravity	50	5 hours.	Room	.0352	.0148
6	.....do	50	5 hours.	Room	.0337	.0140
5	Ammonium oxalate, 40 grams, acetic acid, 2.15 grams per liter.	50	5 hours.	65° C.	.0565	.0200
6	.....do	50	5 hours.	65° C.	.0492	.0185
5	Ammonia oxalate, 40 grams, ammonia, equivalent to 2.15 grams acetic acid per liter.	50	5 hours.	65° C.	.0195	.0135
6	.....do	50	5 hours.	65° C.	.0222	.0175
5	Ammonium chlorid, 17.2 grams, ammonia, equivalent to 2.15 grains acetic acid, per liter.	50	5 hours.	65° C.	.0	.0165
6	.....do	50	5 hours.	65° C.	.0	.0196
5	Total by J. L. Smith method	....	....	....	....	1.467
6	.....do	....	....	....	....	1.485

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[1] Proceedings A. O. A. C., 1896.

SOILS FROM THE EXPERIMENT STATION FARM AT KINGSTON, R. I.

The soil here mentioned is from the "plain." It is of a dark chocolate color, about 4 inches deep, underlaid by an impure clay resting upon gravel and pebbles of unknown depth, which form a good natural drainage. The soil is evidently derived from gneiss, consisting of quartz, orthoclase, and biotite, and made up of glacial drift.

Mechanical analysis.

(1895 Proceedings.)

Made under the direction of Milton Whitney, who remarks that it has "the same texture as our early truck soils."

	Per cent.		Per cent.
Moisture in air-dried sample	1. 90	Fine sand, 0.25–0.1 mm	6. 66
Organic matter	8. 46	Very fine sand, 0.1–0.05 mm	31. 65
Gravel, 2–1 mm	1. 82	Silt, 0.05–0.01 mm	29. 69
Coarse sand, 1–0.5 mm	3. 40	Fine silt, 0.01–0.005 mm	4. 38
Medium sand, 0.5–0.25 mm	7. 82	Clay, 0.005–0.0001 mm	4. 81

Chemical analysis of air-dried fine soil.

(Bulletin 28, Rhode Island Experiment Station. Collected 1892. Hilgard method.)

	Per cent.		Per cent.
Insoluble matter	80. 632	P_2O_5	0. 127
K_2O	. 155	Moisture and organic matter	7. 888
CaO	. 569	Humus	2. 752
MgO	. 209	Ash from humus	. 605
Fe_2O_3	3. 463	P_2O_0 in humous ash	. 042
Al_2O_3	4. 641		

It was found (1895 proceedings) that the amount of P_2O_5 extracted from these soils, rich in organic matter, was increased 41 per cent by substituting the Goss for the above method.

Soil taken from different portions of the same field in 1895 contained, on a water-free basis, humus, 3.86 per cent (by the Huston method, which gives higher results than the Hilgard method, in most cases); humous nitrogen, 0.13 per cent; and free humic acid,[1] 1.52 per cent (Rhode Island station). Soil which had been exhausted of its available potash by fertilization with N and P_2O_5, taken from the same field in 1897, yielded only 0.020 per cent of lime by treatment with carbonated water (1898 proceedings). The soils under discussion give an acid reaction to litmus paper and fail to produce satisfactory yields in the case of many crops, without an addition of lime or other alkaline materials to correct the existing acidity.

In 1890 an experiment was begun with maize to indicate the relative amounts of more active nitrogen, phosphoric acid, and potash within the soil. Previous to this time grass had been growing for many years without fertilization, and hardly enough was produced at the time the experiment began to pay for cutting. In 1890 and 1891 nitrate of soda, 150 pounds; dissolved boneblack, 350 pounds, and muriate of potash, 150 pounds, per acre were applied. In 1892 and subsequently the annual application was increased to 480, 600, and 200 pounds, respectively. In 1896 air-slacked lime was applied to all plots at the rate of 2½ tons per acre.

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[1] Method given in Wiley's Agricultural Analysis, vol. 1, p. 331.

Yields of maize (ears and stover) in pounds.

No.	Fertilizers supplied.	Before liming.					After liming.		
		1890.	1891.	1892.	1893.	1894.	1896.	1897.	1898.
1	N	180	60	60	50	26	10.6	103.3	215
2	P_2O_5	210	129	130	145	88	20.8	32.6	130
3	K_2O	293.8	107.5	61	112.5	28	11.9	133.8	295
4	N, P_2O_5	273.8	139.5	205	122.5	116	38.5	180.3	350
5	N, K_2O	282.5	112.5	88	102.5	32	26.8	222.5	395
6	K_2O, P_2O_5	293.8	157.8	230	163.8	202	49.2	230.8	335

NOTE.—In 1894, 1896, and 1897 other crops were also planted, and the above yields for those years were from a few rows only of maize. The yields during the other years are those from one-twentieth acre plots. No maize was planted in 1895. The experiment is still being continued.

K_2O and P_2O dissolved in digestion of fine soil calculated to water-free basis.

[Soils from Experiment Station farm, Kingston, R. I.]

Plot.	Solvent.	Cubic centimeters solvent to 1 gram soil.	Time of digestion.	Temperature of digestion.	Per cent of P_2O_5.	Per cent of K_2O.
	Frequent shaking by hand.					
5[1]	Citric acid (10 grams per liter)	50	5 hours	Room	0.0178	0.0122
2	.....do	50	5 hours	Room	.0175	.0037
5	Ammonium oxalate, 40 grams, acetic acid, 2.15 grams, per liter.	50	5 hours	Room	.0331	.0142
2	.....do	50	5 hours	Room	.0286	.0054
5	Oxalic acid (6.3 grams per liter)	50	5 hours	Room	.0153	.0158
2	.....do	50	5 hours	Room	.0180	.0077
5	Oxalic acid (1 per cent solvent)	50	5 hours	Room	.0200	....
2	.....do	50	5 hours	Room	.0250	....
5	Oxalic acid (equivalent to 1 per cent citric)	50	2 hours	Room	.0319	.0117
2	.....do	50	2 hours	Room	.0356	.0029
5	Acid potassium oxalate (equivalent to 1 per cent citric).	50	2 hours	Room	.0133	....
2	.....do	50	2 hours	Room	.0189	....
5	Acetic acid (equivalent to 1 per cent citric)	50	2 hours	Room	.0004	.0097
2	.....do	50	2 hours	Room	.0009	.0018
5	Total, by hydrofluoric acid	....	....	....	....	1.542
2	.....do	....	....	....	....	1.659

[1] Proceedings A. O. A. C., 1895.

SOIL FROM THE FARM OF G. F. DOLE, SHELBURNE, MASS.

A good medium loam of glacial origin, a mica-schist till. Had been in grass without manure for five years previous to the following experiment.

The field upon which the experiment to determine available plant food was conducted was upon an elevated tract in a hilly district. One hundred and sixty pounds of nitrate of soda, 320 pounds of dissolved boneblack, and 160 pounds of muriate of potash were annually applied per acre.

Yields per twentieth-acre plot, in pounds.

No. of plot.	Fertilizers supplied.	1889, maize.		1890, maize.		1891, potatoes.		1892, oats.		1893, hay.	1894, hay.[1]
		Ears.	Stover.	Ears.	Stover.	Large.	Small.	Grain.	Straw.		
1 4 8	Av. None	121	124	82	105	27	35	21	32	49¼	57¾
2	N	136	162	90¾	107¼	22	35	24	38½	99	95½
3	P_2O_5	153	148	107¾	94¼	91	50	30	35	65	62
5	K_2O	163	161	93¾	136¼	75	38	26	51½	48½	57
6	N, P_2O_5	172	168	114½	135½	200	51	32	70½	211¾	138¾
7	N, K_2O	185	196	96	129	123	42	37	58	137	98½
9	K_2O, P_2O_5	157	178	108¾	121¼	84	29	21	34	57	75
10	N, P_2O_5, K_2O	175	216	105	122	113	49	39½	65½	158¾	110

[1] The results for 1895, the last year of the experiment, are not included, for there was evidence of the crops from the different plots having been mixed by the person in charge.

Chemical analysis of air-dried fine soil.

[Furnished by W. P. Brooks, Amherst, Mass. Sample collected in 1889.]

	Per cent.		Per cent.
Insoluble matter	80.93	N	0.18
K_2O	.15	Moisture	2.17
P_2O_5	.13	Organic matter	8.41
CaO	.16		

Goss and Hare obtained 0.22 per cent P_2O_5 by the Goss method from soil collected from the same area in 1895.

P_2O_5 dissolved in digestion of fine soil (calculated to water-free basis).

[Soil from farm of G. F. Dole, Shelburn, Mass. Sample was probably collected in 1895 from an unfertilized plot. Frequent shaking by hand. (Proceedings A. O. A. C., 1896.)]

Solvent.	Cubic centimeters solvent to 1 gram.	Time of digestion.	Temperature of digestion.	Per cent of P_2O_5.
N/5 hydrochloric acid	100	5 hours.	40° C.	0.019
N/5 citric acid	100	5 hours.	40° C.	.033
Ammonium citrate (fert. solution dilute 1 in 10)	100	5 hours.	40° C.	.021
N/5 oxalic acid	100	5 hours.	40° C.	.091
Ammonium oxalate (16 grams per liter)	100	5 hours.	40° C.	.011

In answer to inquiries for more definite information concerning soil sample No. 3, distributed by the last referee, with a view to using it in the work of the present year, the agriculturist of the North Carolina Experiment Station writes in part as follows: "The land was apparently a fair representative lot of much of the neighborhood, which generally needs complete manure and organic matter for the production of profitable crops. The cotton, as judged by the stalks left on the ground and the number of empty bolls left, could not be otherwise than deficient in at least one of the essentials of plant food, and we believe in more, or all." This information throws more light upon the character of the sample in question, and emphasizes the difficulty expressed by the referee of last year in obtaining soil of known deficiency for testing the value of a solvent.

Considerable data upon the relative solvent power of dilute acids for phosphoric acid and potash having been secured from time to time upon soils from different localities, they are compiled in the following tables as a more convenient form of reference:

Amount of phosphoric acid dissolved (calculated to percentages of water-free soil).

	Kentucky.		Rhode Island.		Massachusetts.	New Mexico.	Rothamsted, England.	
	Plot 5.	Plot 6.	Plot 5.	Plot 2.			Plot W. 3.	Plot B_2 A.
Proceedings	1895.	1895.	1895.	1895.	1896.	1896.	1897.	1897.
Time of digestion	2 hours.	2 hours.	2 hours.	2 hours.	5 hours.	5 hours.	5 hours.	5 hours.
Temperature of digestion	Room.	Room.	Room.	Room.	40° C.	40° C.	40° C.	40° C.
Strength of acids	n/7.	n/7.	n/7.	n/7.	n/5.	n/5.	n/5.	n/5.
Oxalic acid	0.1135	0.1062	0.0319	0.0356	0.091	0.083	....	....
Citric acid	.0169	.0154	.0107	.0125	.033	.025	....	....
Acetic acid	.0014	.0017	.0004	.0009	....	....	....	....
Hydrochloric acid	....	....	....	....	.019	.049	0.0039	0.0357
Nitric acid	....	....	....	....	....	....	.003	.029

Amount of potash dissolved (calculated to percentages of water-free soil).

	Kentucky.			Rhode Island.		Rothamsted, England.	
	Plot 2.	Plot 5.	Plot 6.	Plot 5.	Plot 2.	Plot W. 3.	Plot B_2 A.
Proceedings	1896.	1895.	1895.	1895.	1895.	1897.	1897.
Time of digestion	5 hours.	2 hours.	2 hours.	2 hours.	2 hours.	5 hours.	5 hours.
Temperature of digestion	40° C.	Room.	Room.	Room.	Room.	40° C.	40° C.
Strength of acids	n/5.	n/7.	n/7.	n/7.	n/7.	n/5.	n/5.
Oxalic acid	0.009	0.0040	0.0087	0.0117	0.0029	....	....
Citric acid	.007	.0040	.0073	.0111	.0021	....	....
Acetic acid	....	.0013	.0043	.0097	.0018	....	....
Hydrochloric acid	.012	....	....	....	....	0.019	0.016
Nitric acid	....	....	....	....	....	.019	.017

It may be noticed that oxalic, citric, and acetic acids decrease in the order named in their ability to extract both phosphoric acid and potash from the soils considered. Hydrochloric acid dissolves more potash from the Kentucky soil than oxalic and citric acids, and from the Rothamsted soil about the same as nitric acid; in regard to phosphoric acid, it extracts more than nitric acid from the Rothamsted soil, but its position in relation to oxalic and citric acids is uncertain, as shown by the Massachusetts and New Mexico soils. The results show how the relative dissolving power of two acids may vary upon soils of different nature, depending possibly upon the combinations in which the ingredient in question occurs.

In considerable of the work done by the association in determining the more active constituents of plant food, the results secured upon a soil which had received no application of a given substance are compared with those upon the same soil to which had been added, in the course of plot experimentation, a known amount of the ingredient in question in an available form. The value of a given solvent has been judged according to its ability to extract a larger amount of a given ingredient from the soil receiving an application of the same than from the one to which it has not been added. Had there been no loss by drainage the differences in the total amounts, at least of a constituent found by analysis, should be accounted for by the net amounts added to or removed from the different plots. In the case of the Kentucky soils (1895 Proceedings) which were deficient in natural drainage, and therefore less liable to loss from leaching, the increase of potash in plot 6 over plot 5 as a result of the system of fertilization during the preceding seven years amounted to 431 pounds per acre, or 0.0431 per cent, using 1,000,000 pounds as the approximate weight of the soil per acre at the depth sampled, 6 inches. It is interesting to compare this percentage with the difference between the percentages of potash found in the soil from plots 5 and 6, as shown below:

	Plot 5.	Plot 6.	Difference.
Goss method (H_2SO_4 and HNO_3)	0.486	0.540	0.054
Official method (HCl 1.115 sp. gr.)	.315	.330	.015
Hydrofluoric acid	1.105	1.147	.042
J. Lawrence Smith method[1]	1.467	1.485	.018

[1] Huston and Bartlett, 1896 Proceedings.

In like manner the increase of phosphoric acid in plot 5 over plot 6 amounts to 486 pounds per acre, or 0.0486 per cent.

	Plot 6.	Plot 5.	Difference.
Goss method	0.450	0.462	0.012
Official method	.430	4.31	.001

It was possible with the data at hand to calculate only approximately the net increase of potash in plot 5 over plot 2 in the Rhode Island soils (1895 Proceedings) during the four years preceding the collection of samples. It would amount to about 460 pounds per 1,000,000 pounds of soil, or 0.0460 per cent.

	Plot 2.	Plot 5.	Difference.
Goss method	0.305	0.287	−0.018
Official method	.152	.156	.004
Hydrofluoric acid	1.659	1.542	− .117
J. Lawrence Smith method	1.549	1.486	− .063

Upon the same basis the increase of phosphoric acid in plot 2 over plot 5 would be 380 pounds, or 0.038 per cent.

	Plot 5.	Plot 2.	Difference.
Goss method	0.251	0.262	0.011
Official method	.191	.202	.011

At the Indiana Experiment Station (Huston and Bartlett, 1896 Proceedings), soil was examined from plots which had been in an experiment five years. Accepting arbitrarily, in the absence of other figures, 1,000,000 pounds as the weight of this soil per acre, at the depth sampled, it appears from the published information that the increased percentage of phosphoric acid, in the plot receiving a complete fertilizer over the blank plots, calculated from the fertilizers applied and crops removed, would be 0.0069 per cent, while the difference in analysis by the official method was —0.005

per cent. The increase in phosphoric acid in the plot receiving barnyard manure over the blank plots appears by a similar calculation to be 0.0119 per cent, and by analysis, —0.016 per cent. The excess of potash in the plot receiving complete fertilizer over the blank plots would, by calculation, be 0.0075 per cent, but according to analysis is 0.021 per cent (official method) and —0.081 per cent (J. L. Smith method). The excess of potash in the plot receiving barnyard manure over the blank plots would by calculation be 0.0176 per cent, but according to analysis is 0.022 per cent (official method) and 0.078 per cent (J. L. Smith method).

It will have been noticed from the foregoing that whereas in a large majority of cases an increased application of an element of plant food to one plot over another has been indicated to some extent by the analysis, in many instances the analytical results are the opposite of what we would expect from the history of the plots. It may be well to state in this connection that, with the exception of those upon the Indiana soil, all results by the official and Goss methods are averages of determinations by a number of chemists; the remaining results represent, as a rule, the work of one person in each case.

It would seem reasonable to expect that the total amount of an ingredient found by analysis would, in the case of the various plots, indicate the ones which had received an addition of that ingredient, even if no correspondence existed with the amounts added during a series of years. On the contrary, the analytical results are very conflicting, showing, in the case of total potash by the Smith method, for example, in two out of the four instances, a considerably larger amount of potash in the soil which had been to some extent exhausted of its supply, than upon that which had received potash for a series of years, and in the other two instances they fail to show the differences which would have been anticipated from the amount of potash applied. Of course, it should not be expected that the analytical results would coincide with the history of the plots, but unless our strong solvents indicate with more certainty than they have in the instances cited the additions of plant food, are we in a position to expect an agreement even in direction, if not in degree, between the amounts dissolved by weak solvents and the records of the soils? As a rule, even our strong solvents previously considered find only a small fraction of the net amount of plant food applied in soluble forms during several years. Conceding the accuracy of our results, it becomes a very interesting problem from an agricultural standpoint to account for this loss.

In studying the results of the past few years, it is apparent that much good work has been done, and that the agreement in the results by different chemists improves. It must be borne in mind, however, that determinations embodying 100 or more grams of soil must be scrutinized to the third decimal place with the same attention that we would give the tenths of per cent in considering the results from a determination embodying 1 gram of material, and that the percentage difference should always be considered in comparing the results from different chemists. The blank obtained by digesting, in a glass receptacle, an amount of solvent equal to that used in connection with the soil, may, in the cases of potash determinations at least, amount to a large percentage of the weight obtained, and should, of course, never be omitted in work of this nature. It is hardly safe for the referee to take it for granted that all necessary precautions will be taken by every cooperating chemist, and he must emphasize them, even at the risk of being considered paternal. In view of the difficulty of obtaining exhausted soils in which the deficient element is positively known, and of subsequently securing a sample of the same which shall truly represent the area under consideration, it would seem advisable to procure, in advance, soil which probably would prove deficient in some essential constituent and, by means of a plot experiment with a portion of the same, settle any doubt as to its deficiency in the particular ingredient. If the soil proves suitable for the work, samples can then be distributed to the chemists, and the results compared with the crop records upon the identical lot of soil. By this method any material, the lack of which might be suspected of being the cause of unproductiveness, instead of the one supposed to be deficient, can be supplied. The experience at the Rhode Island Station with the soil used in the work of this association in 1895, which showed a lack of phosphoric acid before liming, but not afterwards (see article by Wheeler, 1898 Proceedings, p. 60), emphasizes the liability of being misled by many of the soil tests as at present conducted.

Our success in drawing right conclusions in regard to the value of a solvent must depend in a very large degree upon our correct knowledge of the productiveness of the soil, and our carefulness in obtaining representative samples. The writer is forced to the conclusion that with proper attention to these particulars we shall have fewer inexplainable results. We shall very likely be unable to find any one solvent which shall predict the amount of active plant food in soils of very differing characteristics, and, of course, the capabilities of a soil for the production of one crop would be very different for another.

At first thought it was supposed that the relative action of the different solvents employed during the past few years could be explained upon the ground that the principal form in which the ingredients existed in one soil was very different from its combination in another. This difference has undoubtedly been very marked in certain of these soils, but the data at hand seemed insufficient to substantiate deductions upon this point, especially as results by different chemists were sometimes in conflict. It would be highly desirable if there could be published, in connection with the results with the weak solvents, determinations by some experienced chemist, which would throw light upon the peculiar combinations in which the ingredient exists. It must be evident in the case of soils like the ones examined by Ladd, of the North Dakota Experiment Station, for example, in which over half of the phosphoric acid resisted the action of weak hydrochloric acid, though subsequently dissolved with the humus by ammonia, that a dilute acid solvent would fail to indicate the assimilable phosphoric acid with the same completeness as upon a soil containing its active phosphoric acid in forms readily attacked by acids. Evidence is accumulating that there are many soils in which the phosphoric acid is largely associated with the humus, and in a form quite readily available to plants.

In view of the fact that large amounts of soil should be taken when a weak solvent is employed in order to get a fair weight of precipitate, a coarser sieve than the 0.5 mm. size should be adopted for this line of work. After corresponding with a number of chemists in regard to the best size, I recommend the adoption of a 3 mm. sieve, where the soil is to be used for determinations requiring 100 grams or more. This is the size employed quite generally by European workers and its use would be an advantage in comparing results. It would, except in rare cases, include all soil particles which would be appreciably attacked by the solvents in question.

The Chairman. Are there any papers to be presented on this subject, or is there any discussion to be had on this paper?

Mr. Goss. I do not know that I quite followed the referee in regard to these figures on the paper at the front. After a large amount of experimenting I gave up the idea entirely of being able to determine the difference between the several soils—that is, in the amount of available plant food present, by using strong solvents. I do not think it can be done. I think, however, that the strong solvent should be used in the analysis of a soil as a means of determining or attempting to determine the total stock of plant food available that may be drawn upon. Now in regard to difference in results secured by action of the acids that has been mentioned, it has been my experience that this is due often—in most cases—to the presence of lime and magnesia in the soil, which has a neutralizing action. There are a great many soils that will completely neutralize fifth-normal acid. Of course the solvent effect would not be comparable in that case with soils having little carbonate of lime. So this must be taken into consideration in discussing the solvent effect of weak acid.

Mr. Wiley. The point brought out by the referee in the discussion of these data, in which it was shown that, calculating from the amount of material added to the soil, some of these conditions were in the wrong direction, is an extremely important one. It seems to me that that one fact alone should incite the members of this association to enter into a more careful and intimate examination of some of the problems underlying soil analysis. Now everyone will admit that the knowledge of the soil is the fundamental knowledge necessary to scientific agriculture. You may throw the climate in sometimes, but the soil remains stationary, and it is the fundamental environment in which the crops must be grown, not to be changed very much in position or very much in quality. And yet we find that in some cases our methods of analysis seem to point to incorrect results. I think some of the suggestions made will explain the problem. The differences in making a test are very great, for instance, whether we should use a sieve of larger dimensions. It seems to me that it is practically impossible in the methods which we have at hand to make a uniform mixture of these soils. So it seems to me that some of the samples may have been taken which never received any fertilizer at all, and that therefore this would be the explanation. It is a mechanical matter. I would not as the result of this most interesting study throw any imputation upon the skill of the analyst nor upon the method of analysis, but it seems to me, as the referee suggested, that it may be wholly in the method of sampling, and I am inclined to believe that when these discrepancies have been thoroughly investigated it will be found chiefly in just this direction.

Mr. Frear. It seems to me that I can rely on what the secretary has said, that we need to study more carefully the differences in these samples. Several years ago in studying variations in composition of barnyard manure—another substance difficult to sample—I found great difficulty in securing material which I considered as fairly representative. In order to check the matter I took seven series of samples, each one of which would be supposed to be perfectly representative material, but yet I found quite marked differences, making triplicate determinations so as to be sure of my own results. And so I believe that in these closer studies of the soil we will find it necessary to check up our sampling before we too closely criticise results. I think it would be desirable before too severely criticising, or before accepting any man's analysis based upon certain analytical samples, to check up the samples which have been the basis of our determination. I should prefer to examine two or three samples of the same soil.

Mr. HARTWELL. I am glad to have this brought out. I know that in the case of certain of these soils the samples were taken from as few as six places on a 20-acre lot, and in more recent work the soil has been taken from a less number of places than that, and I think the referees must be doubly careful about this matter before requiring a large amount of work by the chemists throughout the country.

A MEMBER. Were there any results on ash?

Mr. HARTWELL. The reporter has had only one or two requests for the samples, and it seemed hardly worth while to send them out. There has been no work done in this direction.

Mr. KILGORE. Mr. President, it seems to me that the interest in the analyses of plants—ash analyses—is becoming pretty general, and we have not gotten very much work in this direction for the last three years. The work on soil has rather monopolized the time of referees and workers, and the idea was suggested by Mr. Hartwell, and I was in hopes he would bring it out, that perhaps it might be a good idea to separate these two subjects and have a reporter on ash in addition to the regular reporter on soils. It would appear that there is enough work there for a referee on each subject. This idea was suggested by the referee himself, and I hoped he would bring it out. I move, Mr. President, that we refer this matter, with the recommendation, to the committee on recommendations, to report back to the association whether they consider it advisable or not to have an additional referee on this subject.

Mr. HARTWELL. In regard to the matter of dividing this work, as the last speaker said, we have had very little results from ash work in the last two years; and in fact for a number of years back the same may be true. This, I think, has been largely because the ash has been considered a separate or side issue, and sometimes has been loaded onto the associate referee; and the simple sending around of a number of samples seems to be more a test of chemists than of method and has not yielded us valuable results. To my mind there is no doubt that there should be considerable work done on our methods of ash analysis, and it would well occupy the attention of a separate referee. The determinations of the soil work and the ash work are very numerous, whereas we have in the case of potash and nitrogen a referee devoted to a single determination. I feel that our methods for ash analysis may lead to incorrect results in this particular, whereas, starting with samples of ash where different results may be had, I think the greater difficulty lies back of that, in starting with the dry material. This is especially true where large amounts of silica and potash are present. Of course our methods emphasize the fact that particular care must be taken in such cases, but in my own work upon ash rich in silica I have been unable to get parallel results, starting with the dry material. Probably it is practically impossible to get all the adherent sand away from the surface of a sample of material, and failing in that we depend upon the determination of insoluble silica to furnish the amount of pure ash in the sample.

In this same connection I would like to call attention to the work of Shuttleworth, who has recently completed his doctor's degree in Germany, and published a monograph on this question which is very interesting. I think this matter could well demand the attention of a separate referee. Especially, as the stations progress in their work, and field experiments are carried on, it will be absolutely necessary to make more determinations of the ash in the future.

The Chairman. You have heard the question of the advisability of dividing the subject of soil and ash analyses. What is your pleasure?

It was moved that the division be made. Carried.

The Chairman. We will now take up the subject of foods and feeding, by Thorn Smith.

Mr. Wiley. The referee is not present, nor is his associate. Both have sent interesting reports, but I would like before reading them to suggest that there has been such a short time since the last meeting that we have not as much before us so we usually have, and it is quite likely that we shall finish in the morning session. For that reason I would like to state that a very important subject will be brought up—a report of the committee on food standards, which seems to me of more interest than any other now before us. This will be presented to-morrow morning, and I hope all who can will be here and enter into the discussion of this highly important subject. I may say that one of the chief reasons for the interest in the matter just now is the fact that the United States Congress, as will be brought out in the report, has recognized the authority of this association already on the subject of food commerce, as the committees in the House and Senate have both reported bills as to interstate commerce in adulterated foods, recognizing this association as the authority for fixing the matter of adulterated foods. It is, therefore, quite certain that in a short period this association will be recognized as the authority in all matters relating to the adulteration of foods, the use of preservatives, and everything of that kind. So I say this is a matter of great importance and should be discussed before a full house. It will come at the end, being put down as the last thing to be done.

I might remind the president that it is his function to say when the report of the committee on nominations shall come in; but this report of which I have spoken will come in immediately before the business of the association is finished. We shall have an hour's business before that comes up, so that it will not come up, probably, before 11 o'clock.

Mr. Thorn Smith, of Moscow, Idaho, writes that he sends his report, saying that it is the best he can do at present.

REPORT ON FOODS AND FEEDING STUFFS.

By Thorn Smith, *Referee.*

It is difficult to understand why such an apathy exists in regard to the perfection of methods for the estimation of the various carbohydrate bodies. Is it because so little is known in regard to this work and our chemists hesitate in taking up something comparatively new, or is it because the perfecting of a method which will obtain results varying but the few hundredths of a per cent by different analysts in regard to phosphoric acid or potash is more important? Is not a comprehensive knowledge of what we eat and feed our domestic animals of more importance than a few hundredths of a per cent of potash? Are we, who have made such rapid strides in analytical methods, to let our foreign friends take this, our grandest opportunity, from us?

In the past few years that the association has devoted itself to this problem of differentiating the nitrogen-free extract, the work has been left in the hands of the few. Widely discordant results have been the reward and a certain amount of depreciation is shown these pioneers. Year after year a few of the faithful have taken up the work, published their results, and gone at the problem with renewed vigor the following year, while their brother chemists let it go by difference and call that difference nitrogen-free extract. How many stations in the country are not called upon in the course of a year for an analysis of something containing these elements reported as nitrogen-free extract, and assigned a feeding value known to be false? Is it not about time that more of us grappled with these problems? If we are to continue our present system of perfecting methods why not have the active cooperation of thirty or more stations instead of the four or five that we now have? It would not take long at this rate to see daylight.

Your referees, not being able to secure the results on the samples sent out this season in time for this meeting, have acted on the suggestion of our honorable secretary and propose to give a very brief outline of the work done by the association on the subject of foods and feeding stuffs as related to the estimation of the starch, pentoses, and galactose. Mr. Browne has prepared a special paper on the subject of starch.

The first suggestion made during a meeting of the association that we should differentiate in what is called the nitrogen-free extract was made, I believe, in 1890. Some work of an individual nature had been attempted in several institutions, but not as a part of the association's work. Clifford Richardson attempted some work in 1883, but abandoned it as unprofitable and not worth the time, considering the labor involved and the lack of suitable methods. It was Mr. Frear who in 1889 said, "I shall be very much disappointed if within the next four or five years a point has not been reached where, instead of being content with the present grouping, we shall in studies of digestibility and nutritive value be satisfied with nothing less than a complete investigation of the foods used." That time has come and gone, twice over, and we are just now making a beginning. In 1890 a committee consisting of some of the most prominent chemists in the association made a lengthy report. W. E. Stone at the same time presented a valuable paper on the estimation of pentosans in feeding stuffs. At this time it appeared as though something were going to be done, but the subject was not mentioned in the next three meetings, except in 1893, when it was suggested by the referees that the subject be taken up. In 1894, however, Mr. Patterson attacked the matter in a vigorous manner, and the work promised much. Only three reported on the subject of nitrogen-free extract; however, the ball was rolling. At the same meeting Mr. Stone and Mr. Krug presented results of valuable study. And yet we had not even a provisional method for this work, not even for starch. The discussion developed nothing, for the subject was not even mentioned. This was truly discouraging to the referees. In 1895 Mr. Patterson continued his labors without success, so far as arousing any discussion was concerned. Was this due to lack of interest or to ignorance of the subject? At this time, however, the referees were successful in having some methods incorporated in the "official methods of analysis."

In 1896 a wise move was made in dropping out of the referee work all other than the differentiation of the nitrogen-free extract. The standing of Mr. Lindsey, the referee, gave prestige to this departure, and, as he said, "These terms do not refer to a single substance, but rather to groups of substances possessing similar charcteristics." And Mr. Lindsey was right. There can be no permanent value in a method which aims to determine several constituents at one time, and if our work accomplishes anything these methods will become obsolete in a few years at the most. Under the vigorous administration of Mr. Lindsey the work so ably started by Mr. Patterson was prosecuted with renewed vigor. At this time also a little interest was manifested in the work. In 1897 Mr. Lindsey again gave valuable assistance in furthering this work. A few points were brought out in the discussion, and yet but few appeared interested. In 1898 the work was taken up by Mr. Krug. He had given considerable attention to it for several years and was ably prepared to carry it along. He was able from the results obtained to recommend material changes and also to propose interesting lines of investigation for future referees. The association has been exceedingly fortunate in having such able and strong men to guide this departure in its initial stages, and it is to be sincerely hoped that the referees of the future will do all in their power to carry on the work so nobly begun.

Gentlemen, I beseech you to give all the aid that you possibly can. Let us demonstrate our ability to cope with this, the most difficult problem that now confronts us. I have told you in as few words as possible, that you may not be wearied, of what the association has done, and I hope that a little more interest may be aroused. Our results lack much to make them satisfactory, and it is only by hard work that we can hope to make them otherwise. Let us wake up to our possibilities and perfect these methods which so perplex us.

In the work outlined for the present year we have made no radical changes. The suggestions of Mr. Krug, last year's referee, have been incorporated in our scheme of analysis, and believing that much of the variation is due to inexperience and manipulation, it can only be a question of time and application before better results are obtained. Seventeen stations are cooperating with us, and we look for good results. While we are unable to make a report at this time, we shall endeavor to report fully at a later date.

MOSCOW, IDAHO, *June 26, 1899.*

MR. WILEY (continuing). Then comes the report of the associate referee:

THE ESTIMATION OF STARCH.

By C. A. BROWNE, JR., *Associate Referee on Foods and Feeding Stuffs, 1899.*

Of all the various methods employed for the estimation of starch, the diastase method stands to-day as the one most universally approved by chemists. In testing the superiority of this over other methods of analysis the Association of Official Agricultural Chemists can pride itself upon having taken a most prominent part. Perhaps no other line of work better illustrates the advantages to be derived from such cooperative researches as the association is undertaking from year to year. We think it fitting, therefore, in this connection to give a brief history of the progress made along this particular subject since the organization of the association.

The analysis of fertilizers occupied the whole attention of the association during the first two years of its existence; the subject of fodders and feeds was not referred to committees until 1886, but for several years nothing was done toward the investigation of those bodies which are still classified as nitrogen-free extract, the attention of the reporters being principally directed to the perfection of methods for determining crude fiber, ether extract, albuminoids, moisture, and ash.

In his address before the association at the Chicago meeting in 1893, the president, S. M. Babcock, suggested a closer study of the different constituents of feeds and advised "substituting for the present illogical, indefinite, and unmeaning system, one which, so far as it went, would deal with the proximate constituents which the fodders contain." A very general demand was made by members of the association for investigation along the lines suggested by President Babcock, and through the energies of the referee on feeds for the following year, H. J. Patterson, the work was given a vigorous start.

Conspicuous among the papers presented at the 1894 meeting is one by W. E. Stone upon "A comparison of methods for the determination of starch." Five of the commonly employed methods were tested and compared upon a large variety of materials. Outside of the samples of pure starch a considerable discrepancy is noted in the results obtained by these methods. Stone shows that this error is due to the presence of other bodies, such as pentosans, which behave toward acids in much the same way as starch, and draws the unavoidable conclusion that none of the existing methods, based upon the conversion of starch to dextrose by direct inversion, can be employed with any degree of accuracy upon materials containing pentosans. The use of diastase, which had begun to meet with favor among European stations, is suggested as one way of meeting this difficulty. We believe that the use of diastase in starch analysis was brought to the attention of the association for the first time on this occasion. The original diastase method of Stone was included among the methods to be tested the following year, but was not reported upon by any of the chemists.

The work marked out by Mr. Patterson was continued for the year 1896 by J. B. Lindsey. Three distinct methods for the estimation of starch were proposed—the Sachsse, the Märcker, and the diastase, the latter method appearing in a form slightly modified from the original. The results of the various analysts demonstrated the inaccuracy of the Sachsse method; the Märcker and diastase methods agreed fairly well, and were adopted by the association as provisional methods until further investigation could be made. In his work the following year Mr. Lindsey dropped the Sachsse method and substituted the salicylic-acid or modified Bundy method for trial instead. A larger number than usual of chemists participated in the work, the general results of the investigation establishing the superiority of the diastase over all other existing methods. The association accordingly adopted the diastase as the provisional method for the determination of starch in all substances except commercial starch and potatoes.

H. W. Wiley and W. H. Krug presented two very important papers on the subject of starch analysis before the Association of American Chemists at the Detroit meeting in 1897. A serious error, due to unconverted starch, was pointed out in the ordinary method of conducting the digestion with diastase, and the importance of testing the residues with iodine under the microscope was shown. The authors also felt "justified in announcing that diastase has no solvent action on the pentosans, and is a reliable means for determining the exact starch content of a cereal or fodder."

The referee for the year 1898, W. H. Krug, limited the work on starch solely to the diastase method. Results were obtained from thirteen chemists. The analyses revealed considerable variation, the probable causes of which are discussed by Mr. Krug to some extent. Differences in the amount of moisture in the different samples, incomplete solution of the starch by diastase, and variations in the time of treatment with the malt solution are all considered as possible sources of discrepancy.

The only important change adopted at the 1898 meeting was in regard to making the iodine test for unconverted starch with the microscope. It is evident that while the process as it stands is the best method which we have at our disposal for estimating starch, there is still need of further improvement at certain points before uniform results can be secured by different chemists.

Mr. Wiley (continuing). Before taking up this subject for discussion, or adjourning, I will say that I have only two more reports, which can be disposed of in an hour, and I think these are the only ones to be taken up. The other referees have not come in person or sent their reports by mail. If we begin by 10 o'clock, I think we can finish our session to-morrow.

Mr. Goss read the following paper:

CONCERNING THE 6.25 PROTEIN FACTOR AS APPLIED TO BEEF.

By Arthur Goss.

In connection with the nutrition investigation work carried out in the New Mexico Experiment Station in 1897, and reported in Bulletin No. 54 of the United States Department of Agriculture, Office of Experiment Stations, the following investigation concerning the 6.25 protein factor was undertaken.

For this work a 2½-year-old range steer, of as nearly as possible average condition, was selected. After butchering one side was cut into fifteen different pieces, as outlined in Armour & Co.'s diagram, which is given below:

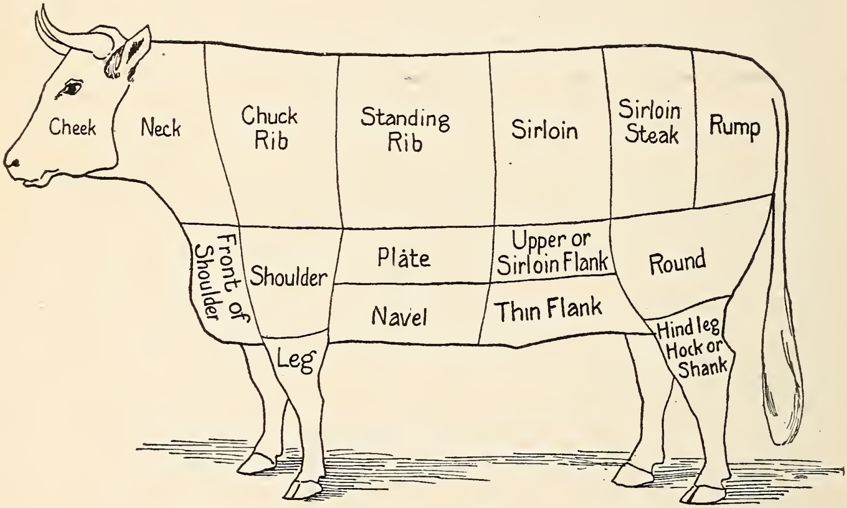

Fig. 2.—Diagram showing cuts of beef used in this investigation.

Each cut was then carefully weighed, the meat separated from the bone, and the amount of each determined. The edible portion of each cut was chopped into very small pieces, the entire lot carefully mixed, and a small sample separated by quartering. The small sample was then run through a sausage mill two or three times, well mixed, and a 200-gram sample weighed into a tared saucer and dried below 100° for two or three days. After drying the sample was allowed to stand in free contact with the air for about forty-eight hours, to assume as nearly as possible a state of moisture equilibrium. After again weighing, and thus determining the per cent of water lost in air drying, the partly dried sample was ground up in an iron mortar as finely as possible and passed through a sieve. Most of the samples were sifted through a half-millimeter sieve, but a few, like the leg, containing much tendon and similar tissue, could not be gotten through so fine a sieve, one or two of the most difficult requiring a 2-millimeter sieve. After grinding and sifting the samples were bottled for analysis.

The substances usually determined in the analysis of meat for the purpose of determining its value as food are water, ash, fat, and protein. In case the water, ash, and fat are determined, the protein is usually taken by difference—that is, the sum of the water, ash, and fat is deducted from 100, and the result called protein. In case it is desired to determine the protein alone, it is usually done by determining the percentage of nitrogen in the sample and multiplying the same by 6.25.

While this 6.25 factor is doubtless practically correct for some proteids, it has been shown repeatedly that these substances differ in their percentage of nitrogen, and that theoretically it would be necessary to use a different factor for each. In the case of an ordinary sample of meat there are always several proteids present, so that in practical work the best that can be done is to secure a factor which shall be as nearly as possible an average for the entire lot.

It was thought worth while in connection with the analysis of the side of beef described above to determine exactly what factor should be used for each particular cut. This side of beef was particularly adapted to this investigation, as the samples contained a very small percentage of fat, and the extremely dry New Mexico climate permitted of drying the analytical samples until little water remained, thus reducing the errors incident to the fat and moisture determinations to the minimum.

In the determination of moisture it was found necessary to dry the samples in a current of dry hydrogen at the temperature of boiling water for about five hours in order to secure practically constant weight.

In the determination of ash the samples were burned in platinum dishes for from three to five hours at a temperature just below redness, the burning in all cases being continued until the ash was perfectly white.

The essentials of successful ash work in the case of meat samples are a good furnace, with the heat under perfect control, and plenty of time. It should not be attempted to hasten the operation by using too high a temperature, as in that case loss is liable to occur from volatilization, and, furthermore, the fusible salts melt and form a coating around the unburned carbon, thus excluding the oxygen necessary for combustion and making it next to impossible to secure a white ash.

The fat was determined by extracting the water-free material in a Soxhlet's extractor with anhydrous ether until all the material soluble in that reagent was removed.

In order to determine the time necessary to accomplish this end, before beginning on the regular samples from the side a series of determinations were run with some samples of round and sirloin steak.

As a result it was found to be necessary to extract longer than twenty-four hours. In all the subsequent work the extraction was continued for forty-eight hours, it being assumed that practically all the soluble material was removed in that length of time.

The results of the above investigation are given in Table 1.

TABLE 1.—*Concerning length of time necessary to extract with ether in the fat determination.*

No. of sample.	Name of cut.	Fat removed first twenty-four hours.	Fat removed second twenty-four hours.	Total fat removed in forty-eight hours.
547	Round steak (animal No. 1):	*Per cent.*	*Per cent.*	*Per cent.*
	a	7.87	0.21	8.08
	b	7.91	.17	8.08
	Average	7.89	.19	8.08
546	Sirloin steak (animal No. 3):			
	a	1.41	.22	1.63
	b	1.55	.22	1.77
	Average	1.48	.22	1.70
548	Sirloin steak (animal No. 1):			
	a	7.91	.15	8.06
	b	7.55	.23	7.78
	Average	7.73	.19	7.92
	Average of averages	5.70	.20	5.90

The fat, so called, even in the case of meat, is never absolutely pure. Probably the principal impurity in the case of meat samples is nitrogenous material, which is either carried down mechanically with the fat or is soluble in ether. In the case of a number of the above samples the ether extract, after being dried and weighed, was dissolved out of the fat flask, transferred into a Kjeldahl digestion flask, and the nitrogen determined in the usual manner. The average of these results, as will be seen by referring to Table 3, was 0.03 per cent of nitrogen, which is equivalent to 0.19 per cent of protein, provided the 6.25 factor is used in calculating. This amount should be deducted from the per cent of ether extract and added to the per cent of protein as determined by difference.

The nitrogen was determined by the Kjeldahl method, 1 gram usually being taken for analysis.

The utmost care was taken in this investigation to secure reliable analytical results. All samples were analyzed in duplicate, and sometimes three or four and even as many as sixteen determinations were made on the same sample. While the duplicate results might have been closer in some cases, provided the samples could have been ground to pass a finer sieve, it is believed that the averages are not very far from correct.

In the nitrogen work all the measuring vessels used were carefully calibrated and the correction factors introduced. It was found in the calibration work that considerably more reliable results could be secured in measuring by the use of pipettes than by means of burettes. An automatic pipette was consequently made and attached to the standard acid bottle, and the acid used measured out in this way. In calibrating this pipette, which held 23.12 cc, a difference of but 0.02 cc was found between the highest and lowest of the four consecutive readings taken.

The next step in the work was a thorough checking up of all the reagents used in the determination. The standard half-normal hydrochloric acid used was prepared by titrating against chemically pure sodium carbonate which had been dried just below redness for four or five hours to constant weight. As a further check on the strength of the acid chemically pure potassium carbonate, dried to constant weight, was used. Upon introducing the proper corrections for temperature of solutions, calibration of pipettes used, etc., and working with the utmost care, it was very gratifying to find that by using Clarke's latest atomic weights the results were almost absolutely identical with the two carbonates.

As a further check on the work samples of bone meal, cotton-seed meal, tankage, and dried blood were secured from Mr. J. P. Street, A. O. A. C., reporter on nitrogen, and check determinations made. This resulted in the detection of a small error due to impurities in the reagent that might otherwise have escaped notice. It also furnished a rather striking example of the unreliability, in some cases, of agreement between duplicate determinations as a means of avoiding error. Upon running a pair of blank determinations with all the reagents used in the nitrogen determination present, in both cases nitrogen was found to be absent. Upon adding a little sugar, however, and making the determination as before, 0.17 cc of half normal hydrochloric acid was neutralized, and upon repeating the determination with a different amount of sugar and different amounts of salicylic acid present an amount of nitrogen corresponding to the above amount of half-normal acid was actually proven to be present in the reagents. The nitrogen was probably present as a nitrate, and had escaped reduction in the absence of organic matter in the first determinations.

In order to determine the length of time necessary to digest the samples with sulphuric acid and mercuric oxid portions of sample No. 548 were digested for one-half, one, two, three, and four hours, respectively. The results secured are given in Table 2.

TABLE 2.—*Showing length of time necessary to boil with sulphuric acid and mercuric oxid in the nitrogen determination.*

Quantity of meat employed.	Sulphuric acid.	Mercuric oxid.	Length of digestion.	Nitrogen.
Grams.	*cc.*	*Grams.*	*Hours.*	*Per cent.*
1	30	0.7	1–2	(a) 13.50
1	30	.7	1–2	(b) 13.50
1	30	.7	1–2	av. 13.50
1	30	.7	1	(a) 13.55
1	30	.7	1	(b) 13.59
1	30	.7	1	av. 13.57
1	30	.7	2	(a) 13.66
1	30	.7	2	(b) 13.55
1	30	.7	2	av. 13.61
1	30	.7	3	(a) 13.68
1	30	.7	3	(b) 13.66
1	30	.7	3	av. 13.67
1	30	.7	4	(a) 13.68
1	30	.7	4	(b) 13.62
1	30	.7	4	av. 13.65
2	30	.7	1	(a) 13.55
2	30	.7	1	(b) 13.47
2	30	.7	1	av. 13.51

The results given above in Table 2 would seem to indicate, as Atwater and Woods have already pointed out,[1] that it is necessary to digest meat samples somewhat longer than ordinary vegetable substances. This work would seem to indicate that three hours' boiling was sufficient in the case of meat samples, but to be safe the boiling was continued in each case in the actual determinations for four hours.

After getting the nitrogen machine in good working order the nitrogen was determined in each sample, and the protein calculated by using the 6.25 factor. The protein was then compared with that found by differences, and the proper factor for the cut calculated.

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[1] U. S. Dept. of Agr., Office of Experiment Stations Bull. 44, p. 25.

In Table 3 is given the correct factor for each cut and the data from which the same was figured. In calculating the protein by difference, the average amount of protein found in the ether extract was deducted from the fat and added to the protein in each case.

TABLE 3.—*Composition and correct protein factor for each cut.*

No.	Name of cut.	Water-free substance.				Edible portion.			
		Ash.	Ether extract.	Nitrogen in ether extract.	Fat. (Protein ether extract deducted.)	Nitrogen.	Protein. N×6.25.	Protein, by difference.	Correct factor for cut.
		Per ct.	*Per ct.*	*Per ct.*	*Per cent.*	*Per ct.*	*Per ct.*	*Per cent.*	
554	Neck	4.7	2.7	....	2.5	15.31	95.7	92.8	6.06
555	Chuck rib	4.7	5.6	....	5.4	14.70	91.9	89.9	6.12
556	Standing rib	4.7	4.7	....	4.5	14.81	92.6	90.8	6.13
557	Sirloin	4.9	3.6	0.05	3.4	14.69	91.9	91.7	6.24
558	Sirloin steak	4.9	3.6	.03	3.4	14.83	92.7	91.7	6.18
559	Rump	5.0	2.6	.03	2.4	15.12	94.5	92.6	6.12
560	Round steak	5.1	4.0	.03	3.8	14.69	91.8	91.1	6.20
561	Hock, hind leg, or shank	4.6	5.9	.04	5.7	14.77	92.3	89.7	6.07
562	Upper or sirloin flank	4.6	2.6	.03	2.4	15.14	94.6	93.0	6.14
563	Lower or thin flank	4.3	3.4	.03	3.2	15.38	96.1	92.5	6.01
564	Plate	4.7	2.1	.03	1.9	15.51	96.9	93.4	6.02
565	Navel	4.4	2.0	.03	1.8	15.65	97.8	93.8	5.99
566	Shoulder	4.9	6.4	....	6.2	14.55	90.9	88.9	6.11
567	Leg	4.3	6.1	....	5.9	14.85	92.8	89.8	6.04
568	Front of shoulder	4.9	3.7	....	3.5	14.88	93.0	91.6	6.16
	Average	....	....	.03	....	....	....	....	6.11
	Equivalent to protein (N × 6.25)	....	....	.19	....	....	....	....	....

By referring to Table 3 it will be seen that the correct factors for the different cuts varied from 5.99 in the case of the navel to 6.24 in the case of the sirloin. In a general way it would seem that for such cuts as the sirloin, sirloin steak, and round steak, in which the greater part of the sample is pure muscular tissue, the 6.25 factor is more nearly correct than in the case of such cuts as the navel, lower or thin flank, and leg, in which tendon and connective tissue is present in comparatively larger quantity. This point is brought out in a more striking manner in Table 4, in which the factors for the different cuts have been arranged in order of size. It will be noted that 6.25 is too high in each case.

TABLE 4.—*Correct protein factors for the different cuts, arranged in order of size.*

No.	Name of cut.	Factor.	No.	Name of cut.	Factor.
565	Navel	5.99	559	Rump	6.12
563	Lower or thin flank	6.01	556	Standing rib	6.13
564	Plate	6.02	562	Upper or sirloin flank	6.14
567	Leg	6.04	568	Front of shoulder	6.16
554	Neck	6.06	558	Sirloin steak	6.18
561	Hock, hind leg, or shank	6.07	560	Round steak	6.20
566	Shoulder	6.11	557	Sirloin	6.24
555	Chuck rib	6.12			

TABLE 5.—*Showing correct protein factor for entire side.*

Edible portion.—Water-free substance.

No.	Name of cut.	Total weight.	Protein (N × 6.25).		Protein by difference[1].	
		Grams.	*Per cent.*	*Grams.*	*Per cent.*	*Grams.*
554	Neck	372	95.7	356.0	92.8	345.2
555	Chuck rib	1,235	91.9	1,135.0	89.9	1,110.3
556	Standing rib	2,311	92.6	2,140.0	90.8	2,098.4
557	Sirloin	1,238	91.9	1,137.7	91.7	1,135.2
558	Sirloin steak	2,098	92.7	1,944.8	91.7	1,923.9
559	Rump	1,270	94.5	1,200.1	92.6	1,176.0
560	Round steak	2,553	91.8	2,343.6	91.1	2,325.8
561	Hock, hind leg, or shank	621	92.3	573.2	89.7	557.0
562	Upper or sirloin flank	427	94.6	403.9	93.0	397.1
563	Lower or thin flank	573	96.1	550.6	92.5	530.0
564	Plate	323	96.9	313.0	93.4	301.7
565	Navel	294	97.8	287.5	93.8	275.8
566	Shoulder	743	90.9	675.4	88.9	660.5
567	Leg	287	92.8	266.3	89.8	257.7
568	Front of shoulder	1,302	93.0	1,210.9	91.6	1,192.6
	Average per cent protein for entire side, by dividing total weight protein in side by total weight dry matter		92.91		91.31	
	Average protein factor for entire side.				6.14	

[1] Corrected for N in ether extract.

In Table 5 is given the data from which the factor for the entire side was figured. It would obviously be incorrect to simply take the average of the factors for the different cuts as the average for the entire side, as the cuts are of different weights. By calculating the amount of protein in each cut as found by difference, and as determined direct by using the 6.25 factor, and dividing the sum of these amounts by the total weight of dry matter in the different cuts, the correct percentage of protein for the whole side can be determined. Then by the proportion—

Per cent of protein by N × 6.25 : per cent of protein by difference :: 6.25 : X

we can determine the correct factor for the entire side. This was found to be 6.14, and if the small amount of carbohydrates said to be present in beef were considered, this factor would become still smaller to a slight extent.

While it is not supposed that this 6.14 factor is correct for all the different proteids, or possibly for any one of them in a pure state, it is thought to be more nearly correct for the average side of beef than is the 6.25 factor used at present.

The proper factor for different animals, or even for the same animal under different conditions, would probably vary somewhat, and it is only by continued work and the accumulation of analytical data that the true relations in such cases will become apparent.

In Table 6 is given the average results of the analyses of three samples of round and sirloin steak from different animals, as purchased in the market. In sampling, as much fat as possible was removed, the object being to secure as nearly pure muscular tissue as possible. Even though as much fat as possible was removed, there still remained considerably more of that substance in some of the samples than was present in the samples from the range animal, showing that the animals from which these samples were taken were in much better condition than the range steer.

TABLE 6.—*Composition and correct protein factors for samples of pure lean round and sirloin steak.*

No.	Name of cut.	Water-free substances.						
		Ash.	Ether extract.	Protein in ether extract N × 6.25	Fat.	Protein by difference.	Protein by direct determination N × 6.25	Correct protein factor for cut.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
547	Round steak as sold in market, animal No. 1	4.6	8.2	0.25	8.0	87.4	88.3	6.19
548	Sirloin steak as sold in market, animal No. 1	4.5	8.1	....	8.0	87.5	87.8	6.23
549	Sirloin steak as sold in market, animal No. 2	4.5	9.8	.06	9.6	85.9	85.6	6.27
	Average	....	....	.16	....	....	....	6.23

By referring to Table 6 it will be seen that the average protein factor for these samples is considerably nearer 6.25 than the average factor for the range animal. Upon comparing the averages for the corresponding cuts, however, it will be seen that there is not very much difference, the average for the corresponding cuts from the steer being 6.19, and for the samples from the shop 6.23.

This would seem to confirm the statement already made that the 6.25 factor is probably more nearly correct for such cuts as round and sirloin steak, in which the greater portion is pure muscular tissue, than for such as the leg and flank, in which there is much tendon and connective tissue. It is not to be overlooked, however, that the comparatively few samples analyzed would not warrant any very definite conclusions in this connection.

It would afford an interesting study to dissect out portions of tendon, pure muscular tissue, etc., and compare the protein factors for each.

Mr. WOODS. In connection with the paper just read, I am afraid we must not pin too much faith to that kind of work unless we go back somewhere else. If we take meat and dry it at the temperature of this room with the air pump you will lose nitrogen. Anywhere from 2 to 15 per cent of the nitrogen in the meat will go off in the air; and you will also find that if you extract meat with ether it will give off ether extract almost indefinitely. You will also find that if you dry two duplicate samples of meat in a stream of hydrogen, and in one case the hydrogen does not pass through the dish, they will not agree. They will be as far as 2 or 3 per cent apart. I have compared 750 of these samples, and I doubt whether we can do very much in just this way. We have got to separate the materials and study them by themselves. We have got to experiment upon an enormous amount of meat before we can learn much about the composition of it. I think in order to study this matter, interesting and painstaking as this work is, and valuable as it would be if we are sure of the facts back of it, we have got to take it with considerable allowance.

Mr. GOSS. If it is true, as Mr. Woods has stated, that nitrogen is lost in drying, then this factor should be even less than 6.15—6.25 is undoubtedly too much.

Adjourned.

THIRD DAY'S PROCEEDINGS.

President Kedzie called the association to order.

The president called for the report on foods and food adulterations, by Prof. H. A. Weber. Professor Weber was not present, and the secretary stated that he had sent no report, and suggested that the discussion of the subject be postponed, to be held in connection with the report of the committee on food standards, which was to come later.

The president then called for the report of the referee on insecticides and fungicides. In the absence of the referee, Dr. de Schweinitz, the associate referee, Mr. L. A. Voorhees, presented a report, which was read by the secretary, as follows:

REPORT ON FUNGICIDES AND INSECTICIDES.

By Louis A. Voorhees, *Associate Referee.*

The Association of Official Agricultural Chemists, until its third annual convention of 1886, confined its efforts and the scope of its work to the analysis of fertilizers. Committees had been appointed and work much needed at that time had been done on the methods of determining phosphoric acid, potash, and nitrogen. At this third convention, however, the importance of the chemical examination of cattle foods and dairy products caused the association to unanimously adopt such changes in its constitution as to permit it to include committees on these and other materials connected with the agricultural industry; and since this time we find the importance of the work causing that on nitrogen to include the determination of nitrates, ammonia salts, and organic nitrogen, and their availability; that on potash to consist of a strict and discriminating examination of the various steps in the methods and variations applicable to the various salts and other substances to be met with; and that on phosphoric acid to comprise many new methods and to embrace the determinations of iron and alumina. The methods for the examination of soils and ash have been assigned to a separate committee, and involve the determination of all the common mineral constituents of plants and soils.

Reporters on tanning materials and on sugar have been established, and work on cattle foods and dairy products has grown to the extent of including a more exhaustive examination of the nitrogen-free extract in the case of the former and a search for adulterations, preservatives, etc., in both cases. This has naturally led to the examination of food intended for man, so that flour, meal, bread, spices, condiments, baking powders, vinegar, etc., have received our attention in response to the demands of our station workers in animal industry and in the nutrition of plants, the lower animals, and man.

In the meantime our coworkers with the microscope, the botanists and entomologists have been making progress, and consequently now make their demands of the analytical chemist. At the time of the third convention referred to (1886) there were barely half a dozen scientific men in the United States working from an economic standpoint on the problem of plant diseases, their injuries, life histories, characteristics, and preventives.

When in 1888 the experiment stations were established in the various States, the subject of plant diseases was at once recognized as one of the important lines of work, it being, in fact, specially mentioned in the organic law upon which they were founded; and in many stations investigators at once began work upon the problems involved. Results of immense practical importance have already been obtained in these investigations and experiments, and it is safe to say that had the experiment stations done nothing more for agriculture than to obtain these and other similar results concerning plant diseases, the money spent upon them by the Government would have been wisely invested.

Likewise, as the experiment stations were organized and the agricultural colleges were enlarged and strengthened by Government assistance, the vital importance of economic entomology to successful agriculture became recognized. The increase in noxious insects from various causes, not the least of which is their enormous power of multiplication, led to a constantly increasing injury to cultivated crops. With this increase, however, our knowledge of controlling them has also been augmented with the passing years. Spraying has become a recognized part of the season's operations, as much so as fertilizing and cultivating, and hence demands and receives very large attention from the workers of the agricultural experiment stations, and worthily, since in many sections the depredations of insects and blight of fungi prevail, whereas the questions of artificial fertilization are there just arising.

With the increase in the use of "chemicals" as fungicides and insecticides, the mycologist and entomologist have become more and more in need of the assistance of the analyst; the temptation to adulterate is greater than when comparatively small amounts of these chemicals were used by the agricultural public; imitations have been devised, and the mixtures and combinations of chemicals have been prepared and put upon the market "ready-made." Recognizing this increasing field of agricultural chemistry, analytical control (particularly of arsenicals) has been established in some States after the manner of the fertilizer control, and at its last meeting this association took the matter under consideration and appointed a referee and associate to study the methods to be employed. It is to be regretted that sufficient time has not been available to give the subject exhaustive treatment, and that this report is, therefore, but introductory.

The principal chemicals and other substances in use by entomologists and mycologists at the present time are contained in the following list, which may, however, be incomplete:

Ammonia (aqua).
Arsenicals.
Calcium oxid (fresh lime).
Carbon disulphid.
Copper carbonate.
Copper sulphate (blue stone).
Lead acetate (sugar of lead).
Mercuric chlorid (corrosive sublimate).
Potassium cyanid.
Potassium sulphid.
Potassium hydoxid (potash lye).
Sodium carbonate.
Sodium hydroxid (soda lye).
Sulphur, flowers of.
Sulphuric acid.
Carbolic acid.
Fish oil.
Formalin.
Kerosene oil and crude petroleum.
Pyrethrum.
Tobacco preparations.
White hellebore.

Of these materials practical experience seems to indicate that ammonia water, fresh lime, carbon disulphid, copper sulphate, lead acetate, mercuric chlorid, potassium sulphide, sodium carbonate and hydroxid, flowers of sulphur, sulphuric acid, carbolic acid, fish oil, kerosene, crude petroleum, pyrethrum, and white hellebore are either sufficiently uniform in quality or are of the strength designated by the manufacturer. On the other hand, copper carbonate could be adulterated. Potassium cyanid ranges from 68 to 98 per cent of purity, which is of importance to the nurseryman in fumigating his houses, not only because the hydrocyanic gas may be diminished in amount, but also because of the injury to his stock from the deleterious gases which may be liberated from the impurities, and 98 per cent pure should always be insisted upon. "Potash lye," in the trade, has been found in many instances to be sodium hydrate, which concerns not the mycologist so much as the entomologist in making up a "whale oil" soft soap. Formalin is supposed to be a 40 per cent solution of formaldehyde in water, but its uniformity has been questioned, since it has sometimes failed to preserve specimens in the laboratory. Tobacco and tobacco preparations depend for their efficiency largely upon the nicotin which they may contain, and there are also various imitations and ready-made preparations (proprietary) on the market which demand analysis.

But the materials which are most in need of examination and control are the arsenicals—Paris green, London purple, and the various substitutes and imitations are extremely variable. In 1897, 11 samples of Paris green were examined by Prof. William S. Myers, of Rutgers College, for the entomologist of this station, and to his report was appended the following comment:[1]

> The above results varying so widely—from 41.54 per cent of arsenious oxide to 68.59 per cent—seemed difficult to understand on first comparisons. According to the last edition of the United States Dispensatory, Paris green is the aceto-arsenite of copper. The theoretical percentage of arsenious oxid in it is 58.65. The Massachusetts Report for 1895 gives the average of a number of samples as 59.94 per cent, and Mr. Cathcart, in the New Jersey Experiment Station Report for 1890, who states that there are two compounds sold under the name of "Paris green"—the arsenite as well as the aceto-arsenite of copper—finds as high as 68.82 per cent of arsenious oxid in a sample. The arsenite of copper, according to Sharples (Chemical News, 35, 88–108), contains only 41.93 per cent of arsenious oxid, but is subject to wide variation in composition and purity, depending upon the degree of concentration of the liquid from which the body is crystallized. With no water of crystallization, the arsenious oxide may run as high in the pure pigment as 52.95 per cent.
>
> Bloxam and older authorities have published formulas requiring from 50 per cent to 70 per cent of arsenious oxid. According to Wagner, the other body, the aceto-arsenite of copper, is only an empirical formula, in which the copper may exist as suboxid and the arsenic be present as arsenate. Here is also an opportunity for considerable variation from the theoretical per cent of 58.65. It is not, therefore, surprising to find wide variations in the commercial products, when we have three possible theoretical figures, viz, 41.93 per cent, 52.94 per cent, and 58.65 per cent, and, when actual figures have been obtained, as high as 59.94 per cent and 68.82 per cent. We have no reason to believe, consequently, that the samples were adulterated.

In addition to the Paris green there are found on the market many preparations in imitation of or as substitutes for it. The Maine Experiment Station (Bulletin 52, p. 6) notes the following: "Green arsenite," "Paragrene," "Emerald green," "Arsenite of soda," and "Arsenate of lead." Green arsenite is the plain arsenite of copper, as noted in Professor Myers's comment above, but the New York Experiment Station at Geneva (Bulletin 158, p. 14) notes that "Lead arsenite is also colored and sold under the incorrect name 'green arsenite.'" In addition, "New process Paris green, Lion Brand," and "Laurel green," analyzed at the Kentucky Agricultural Experiment Station (Tenth Annual Report, 1897, pp. xx, xxi), are shown to be mixtures containing little Paris green, if any.

The Adler Color and Chemical Works have recently put upon the market an arsenate of lead, an arsenite of lead (which they call "Pink arsenoid"), an arsenite of copper ("Green arsenoid"), and an arsenite of barium ("White arsenoid").

From all of this it would seem that analytical work on insecticides and fungicides is much needed, and at present should include the following determinations: Copper, cyanogen, alkalies, formalin, nicotin, and arsenic.

On account of the absence of the referee for this subject, and the earliness of the convention of the association, there has been no time for analytical work in these directions, but the following methods are proposed for study and experiment.

A qualitative analysis should precede in most cases, especially in unfamiliar goods, and may for some purposes take the place of the quantitative determination. The regular tests may be used. Wendell Paddock (New York Exp. Sta., Bulletin 121, p. 219) proposes the following quick test, though not infallible, of the purity of paris green:

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[1] N. J. Exp. Sta. Report, 1897, p. 408.

Pure Paris green will readily dissolve in ammonia, and the solution will be of a deep blue color. If there is any residue left, or if the solution does not become blue at once, adulteration may be suspected.

Formaldehyde may be qualitatively detected in an unknown solution by the tests described on page 113 of the proceedings of the convention of this association in 1897 (Bulletin No. 51, Division of Chemistry).

QUANTITATIVE METHODS.

The following quantitative methods are suggested:

Copper.—Determine copper as cuprous sulphid by Rose's method, Fres. Quant. Anal., edition of 1886, page 316. This, slightly modified, is as follows: Precipitate the solution—which is best moderately acid, but should not contain a great excess of nitric acid—according to the quantity of copper present, either by the addition of strong hydrogen sulphid water or by passing the gas. In the absence of nitric acid it is well to heat nearly to boiling while the gas is passing, as this makes the precipitate denser, and it is more easily washed. When the precipitate has fully subsided, and you have made sure that the supernatant fluid is no longer colored or precipitated by strong hydrogen sulphid water, filter quickly, wash the precipitate without intermission with water containing hydrogen sulphid, and dry on the filter with some expedition. Transfer to a weighed porcelain crucible, add the filter-ash and some pure powdered sulphur, and ignite gently while the sulphur vapor is burning quietly around the crack in the cover. As soon as this has ceased heat strongly for five minutes, allow to cool in the stream of hydrogen, and weigh the cuprous sulphid (Cu_2S).

Potassium cyanid.—Determine purity by Liebig's volumetric method. It is based on the fact that when a solution of silver nitrate is added to an alkaline solution containing cyanogen, with constant stirring, no permanent precipitate of silver cyanid occurs until all the cyanogen has combined with the alkali and the silver to form a soluble double salt (in the presence of potash, for example, KCy, AgCy). If the slightest excess of silver over and above the quantity required to form this combination be added, a permanent precipitate of silver cyanid occurs, the double compound being destroyed. If, therefore, the silver solution be of known strength, the quantity of cyanogen present is easily found; 1 eq. of silver in this case being equal to 2 eq. cyanogen.

"So fast is this double combination that when sodic chlorid is present no permanent precipitate of silver chloride occurs until the quantity of silver necessary to form the compound is slightly overstepped." (Sutton's Volumetric Analysis, edition of 1890, p. 173, which see for further details, and also Fresenius Quant. Anal., edition of 1886, p. 450.)

Alkalies and alkalinity.—Any of the standard methods may be used both for the alkalies and for the alkalinity of the ash of the various soap preparations.

Formalin.—Employ the method of Blank and Finkenbeiner (Ber. 31, (17) (2979), of which the following is an abstract:[1]

Three grams of the solution are weighed off into a tall Erlenmeyer flask containing 25 to 30 cc of double normal sodium hydroxid; 50 cc of pure 2.5 to 3 per cent hydrogen peroxide solution are then gradually added during a space of three minutes through a funnel placed in the neck of the flask to prevent spurting. After standing two or three minutes the funnel is washed with water and the unused sodium hydroxid titrated with double-normal sulphuric acid, using litmus as indicator.

When analyzing solutions containing less than 30 per cent of formaldehyde, the mixture must be allowed to stand ten minutes after adding the hydrogen peroxid to complete the reaction.

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[1] Journal of the Society of Chemical Industry, Vol. XVIII, No. 1 (Jan. 31, 1899), p. 79.

The percentage of formaldehyde is found by multiplying the number of cubic centimeters of soda solution used by 2 when 3 grams of substance are taken.

Acetaldehyde reacts much more slowly with the reagent than formaldehyde, and it is doubtful whether the reaction is quantitative. Paraldehyde reacts still more slowly with hydrogen peroxide, even in the presence of a trace of ferrous salt. Benzaldehyde is acted upon more quickly, particularly in presence of ferrous sulphate, and a considerable evolution of gas takes place, but a long time is needed to complete the reaction.

Nicotin.—No work has been done in this direction which warrants a change from the method proposed by Kissling, which was found by McElroy to be the most simple and reliable,[1] but it is suggested that the modification proposed by Prof. A. L. Winton on p. 125 of the proceedings of the last convention of this association[2] be given a comparative trial.

Arsenic.—By precipitation with hydrogen sulphid and weighing as arsenious sulphid. This method is applicable to Paris green and other compounds of arsenic with metals of Group V, except mercury. (Compare Fresenius Quant. Anal., edition of 1886, p. 350 and p. 556.) Dissolve with hydrochloric acid; heat the solution in a flask (preferably on an iron plate or similar arrangement) to about 70° C. and conduct hydrogen sulphid at the same time into the fluid as long as precipitation takes place. The precipitate formed is a mixture of sulphur and arsenious sulphid, with the sulphids of the metals of Group V. Spread out the filter in a porcelain dish with watch-glass cover, and digest over a water bath with sodium sulphid solution. Decant and repeat the digestion two or three times. Finally add some water, filter off with clear solution and wash the residue with hydrogen sulphid water. This residue is to be examined for metals of the fifth group. If only copper is present, the precipitate may be immediately dried, burned, and weighed as cuprous sulphid, as already described.

The sodium sulphid solution is warmed and made acid with hydrochloric acid, which reprecipitates the arsenious acid and a large amount of free sulphur. Filter and wash; extract the still moist precipitate on the filter with ammonia, wash the residual sulphur, reprecipitate the solution with hydrochloric acid without heat, filter on a Gooch crucible, dry, extract the remaining free sulphur with carbon disulphid, dry at 100° C. and weigh, repeating the extraction and drying until constant weight is secured. From the arsenious sulphid (As_2S_3) compute arsenious oxid (As_2O_3).

If small quantities of copper, etc., are to be separated from much arsenic, the following is a better method: Dissolve with hydrochloric acid and oxidize with potassium chlorate; then pass the hydrogen sulphid for a short time. The copper is precipitated before the arsenic begins to come down. If the latter is questioned, there is a much smaller precipitate to be extracted with a little sodium sulphid solution; the extract thus obtained is to be acidified with hydrochloric acid and added to the former filtrate containing the principal quantity of the arsenic. Then proceed to precipitate the arsenic with hydrogen sulphid.

At the conclusion of the report of the referee the president called for papers on this subject. None being presented, discussion was called for.

Professor Colby asked if the methods recommended by the referee applied to the determination of free arsenious acid.

The secretary said that no special method was given for that, but that the general method employed would be able to distinguish the free arsenious acid from the acid in combination.

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[1] Wiley, Principles and Practice of Agricultural Analysis, Vol. III, p. 606.

[2] Bull. 56, Division of Chemistry, U. S. Dept. of Agriculture.

Mr. Kilgore. I will say a few words in regard to the existence of free arsenic in insecticides. The best work which this association could do would be to determine the definite form of the compounds in the arsenical insecticides. The foliage of plants, as is well known, is injured by soluble arsenical compounds, such as free arsenic, whereas the insoluble compounds do not in any way injure the leaves. For instance, the arsenic in London purple is partly soluble, especially when the London purple is made as a by-product in the manufacture of aniline. Wherever there is any suspicion of the presence of free arsenical compounds it is advisable to treat the insecticide with lime before use; this treatment producing an insoluble arsenical compound of lime. I have found that in the substance sold as London purple there is a residue from the manufacture of aniline that is a rose aniline compound of arsenic which is soluble in water. The addition of lime decomposes this soluble compound and makes an arsenate of lime which is innocuous, so far as the foliage is concerned, yet deadly to insects.

Professor Blouin stated that Louisiana had a law regulating the sale of Paris green, and requiring that there should be a minimum content of arsenic of 50 per cent. He had the suspicion that phosphoric acid was sometimes added as a substitute for arsenic, since some of the methods of precipitation of arsenic precipitated also phosphoric acid as a simple compound. This was especially true of precipitates formed by molybdic acid and its compounds. He briefly described the methods of analysis employed by him in the work in Louisiana.

Mr. Shaw. The Oregon station has done a limited amount of work upon insecticides, principally upon Paris green and the relative alkalinity of commercial concentrated lyes. Our examination of the Paris green sold in our markets shows that about 44 per cent was below standard. The most common adulterant proved to be gypsum. There was a wonderful difference in the physical appearance even of the material which was up to standard. That in which the granules were small was always of a paler color than when the granules were large. In some of the Paris greens of our market there were, without doubt, evidences of considerable free arsenic which, while it might add to its poisonous qualities, would also give greater tendency to burn the foliage and therefore render a condition of that kind undesirable. We have obtained good results by oxidizing with potassium chlorate removing chlorin and precipitating with magnesia mixture after making alkaline with ammonia. It was found necessary to be very careful in the removal of the chlorine before adding the precipitating reagent. We also found it necessary to moisten the filter paper with a solution of ammonium nitrate before burning. Our work on concentrated commercial lyes has not been done in the way of complete analysis, but rather confined to the total alkalinity or the amount of pure alkali to the pound of lye. We have found a wonderful variation not only from the strength which might be expected from a good quality of lye, but also strength claimed by manufacturers.

The president called attention to the use of insecticides in Michigan, and stated that injury to the foliage by the use of soluble arsenical compounds had frequently been observed. He described briefly the methods of preparing the lime insecticides.

The recommendations of the referee on fungicides and insecticides were referred to the committee on recommendations, with request to report before the adjournment of the morning session.

The report of the referee on dairy products was then called for.

The referee, Mr. J. B. Weems, not being present, his report was read by the secretary, as follows:

REPORT OF REFEREE ON DAIRY PRODUCTS FOR 1899.

By J. B. Weems, *Referee.*

In reviewing the work of the association relating to the investigation of subjects connected with dairy products one finds that the first report on the subject was made by Dr. H. W. Wiley as reporter, at the fourth convention in 1887. The work of this year consisted in the comparison of the results from eight analysts who tested four samples of butter, butterine, and oleomargarine sent to them by the reporter. The tests made upon the samples were the determination of specific gravity, melting point, volatile acids, soluble acids, insoluble acids, salt, and curd.

In 1888 Dr. Wiley was again the reporter on this subject. The report was a résumé of the work during the year, as no samples were sent out to the members of the association.

At the annual convention in 1889 Dr. Wiley made his third report as reporter on dairy products. The work of this year consisted in the examination of one sample each of oleomargarine, butterine, and butter. The results of the determination of the specific gravity, melting point, and volatile acids were received from twenty-two analysts and compared in this report.

Dr. E. H. Jenkins was the reporter on dairy products at the convention in 1890, and in his report it is found that eleven analysts made determinations of water, casein, fat, ash, and salt in one sample of creamery butter sent to them.

In 1891 Prof. W. W. Cooke was the reporter. The work of the year was upon the determination of solids, fat, casein, sugar, and ash, in one sample of milk. Results were received from ten chemists, and in their work the analysts made determinations of solids in the milk by drying at a temperature of 100° and 105° with sand and asbestus. The amount of fat obtained by drying on paper, sand, and asbestus, and then extracting with ether were compared, also the results obtained by the Babcock, Parsons, and Beimling methods.

At the ninth convention Prof. S. M. Babcock made the report for the year, and consideration was given to the following:

(1) The comparison of the results obtained by the Leffman-Beam method of saponification with those obtained by the official method.

(2) The comparison of the results obtained by using glass and block-tin condensers in the determination of volatile acids in butter fat.

(3) The necessity of melting the free fatty acids before distillation.

(4) The comparison of methods of cheese analysis.

During this year no samples were sent out by the reporter. Results were received from five chemists. These results indicated that in the comparison of the Leffman-Beam method with the official, the Leffman-Beam method gave results which were 0.84 cc lower than the official method. The results obtained from the use of glass and block-tin condensers indicated that the results obtained with the block-tin condenser were lower than those with the glass condenser. No definite conclusion was reached on the question of melting the free fatty acids before distillation.

The work on the methods of cheese analysis included a comparison of the results obtained in drying cheese over sulphuric acid and at 100°, the drying of the extracted residue over sulphuric acid and at a temperature of 100°, and a comparison of results obtained by the Babcock and Short methods. The report made at the tenth convention in 1893 was by Mr. A. L. Winton and consideration was given to the following subjects:

(1) The drying of cheese and ether extract in air and hydrogen.

(2) The determination of solids and fat in milk by means of asbestus in a perforated metal cylinder.

(3) The comparison of results obtained by the direct determination of solids in milk and the calculation of the same from the specific gravity and the percentage of fat.

In the investigation of the methods of drying cheese it was found that the results were about the same when dried in air and hydrogen. Some of the samples were found to lose weight when dried for forty hours, while most of the water was lost in four hours. The method of drying milk on asbestus in a perforated cylinder for the determination of solids and the extraction of the same for the fat is summed up in the report with the statement "for simplicity and convenience the cylinder method can hardly be equaled." The results obtained from extracting the solids of milk dried in air and hydrogen were practically the same. The result of the investigation on the comparison between the direct determination of solids in milk and that calculated from the specific gravity and the percentage of fat showed that the formula of Hehner and Richmond gave the most satisfactory results.

Prof. E. H. Farrington was the reporter on dairy products at the eleventh annual convention. The work of this year was a repetition of a part of the work of the previous year and consisted of a comparison of the results obtained by the direct determination of solids in milk with those calculated from the specific gravity and the percentage of fat by the formulas of Fleischmann, Babcock, Hehner and Richmond, and Richmond. In addition to this work there was an investigation in which the results obtained by extracting the fat of milk dried on sand and asbestus were compared with the results obtained by the Babcock method. The result of the work of the year showed that the comparison between the direct determination of solids in milk and the calculation from the specific gravity and percentage of fat was in favor of the formula of Hehner and Richmond. The comparison of the results obtained by the usual gravimetric methods with those from the Babcock method in the determination of fat in milk resulted in a very satisfactory manner. In a series of experiments to determine whether there is any loss of fat in the souring of milk, it was found that there was practically no loss when milk had been kept for three months.

In the investigation of the question whether the solids of milk change when allowed to sour on sand and asbestus, it was indicated that "there was a decrease from day to day in the percentage of solids and ether extract found in milk weighed and allowed to sour on sand, while in that treated in the same manner with asbestus the decrease was much smaller."

Prof. E. H. Farrington was the referee on dairy products for the second time at the annual convention in 1895. A circular letter was sent to fifty chemists, in which the suggestion was made that "it is your reporter's opinion that more and better work may be done if each chemist will send to him, on or before August 1, 1895, a report on some work of his own selection, rather than for me to attempt to supply samples and directions for investigations."

The topics to which attention was invited by the referee were as follows:

Cheese analysis:

I. Fat
- 1. By the Babcock test.
- 2. By drying at 100° C. and extracting.
- 3. By provisional method adopted.
- 4. By modification of provisional method adopted.

II. Determination of acid in cheese.
III. Determination of different classes of nitrogen compounds.

The determination of albuminoids in milk:

I. What is the correct factor for casein and albumin?
II. Does the Ritthausen method precipitate all the albuminoids and in a state of purity?
III. How are the casein and albumin best determined separately?
IV. What is the amount of nonalbuminoid nitrogen in milk?

There was only one result from the letter of the reporter, and that was a communication from Prof. S. M. Babcock on the comparison of results from the direct determination of solids in milk and the calculations of the same from the specific gravity and percentage of fat.

The reporter for the thirteenth annual convention was Dr. L. L. Van Slyke. In the work of this year consideration was given to the analysis of cheese, and special attention to the preparation of sample and determination of fat, and some study of the acidity of cheese.

The following methods for the determination of fat in cheese were considered:

I. The present provisional method (1895).
II. The same, modified.
III. The extraction of fat after drying.
IV. The Babcock test.

The provisional method was at that time, stated briefly, as follows: "The sample of cheese was ground with about twice its weight of anhydrous copper sulphate and then extracted with ether." The proposed modification had for its object the prevention of possible loss of fat, by grinding the weighed sample after most of the fat had been extracted.

The extraction after drying was as follows: Weigh out 2 to 5 grams of cheese, dry at a temperature of boiling water for ten hours, then extract with ether. After five hours remove the cheese and grind with some incinerated sand. Replace in flask and continue extraction for ten hours longer. The results obtained from the work of three chemists were as follows:

	Per cent.
Provisional method	38.55
Provisional method modified	39.23
Extraction after drying	39.69
Babcock test	39.81

The results of the work as a whole indicated that in the extraction methods the fat of cheese is not entirely extracted.

The report on dairy products at the fourteenth annual convention was made by Dr. L. L. Van Slyke as referee. This report was limited to the determination of casein and albumin in milk. As a result of the work of the year the referee made a number of recommendations, among which were the following:

1. That the provisional method for determining casein in cow's milk be made official.

2. That the modified provisional method for determining albumin in cow's milk be

substituted as a provisional method for the present provisional method, and that further cooperative work be done on the determination of albumin.

3. That the magnesium sulphate method for determining casein in cow's milk be made an official optional method.

In addition to the report on the investigation of methods for the determination of casein and albumin in cow's milk, the referee considered the question of adulteration in dairy products, and called especial attention to the methods for the detection of adulteration in milk, butter, and cheese.

Prof. C. L. Penny made the report on dairy products as referee at the fifteenth annual convention in 1898. The work of the year was a continuation of the study of methods for the determination of casein and albumin in milk and the comparison of methods for the determination of volatile acids in butter, as follows:

1. Compare the provisional method of saponification, using a reflux tube or condenser (Circular 4, p. 3), with the official method prescribing a closed flask.

2. Compare with the official method of saponification the Leffman-Beam method, using, if possible, both fresh and rancid butter. (See Analyst, Vol. XVI, p. 153; Vol. XVII, pp. 65 and 176, and Vol. XXI, p. 259.)

The results of the investigation of the methods of saponification as outlined above were very satisfactory, as shown by the recommendations of the referee.

In connection with the reports of the referees made at the annual conventions, there have been a number of papers presented by members of the association, on subjects connected with the investigation of dairy products, and in this connection the following list of papers may be of interest:

The fourth report contains "Average of analyses of American butters," by Edgar Richards, and "Variations in the composition of butter," by S. M. Babcock. The fifth report contains "The milk of Washington not normal," by C. Richardson; "Notes on the method for soluble and insoluble fat acids," by G. E. Patrick, and "Refractive index of butter fat," by H. W. Wiley.

The eighth report has two papers, one by W. W. Cooke, on the "Analysis of sour milk," and the other by G. E. Patrick, on "Composite milk samples in the laboratory." In the tenth report, we find "The determination of casein in cow's milk," "The determination of fat in cheese," and "The determination of acidity in milk," by L. L. Van Slyke, and "The determination of solids and fat in milk by drying with asbestus in a perforated metal cylinder," by A. L. Winton.

The eleventh report contains "The determination of albumin in cow's milk," by L. L. Van Slyke, "Does cream lose fat on keeping a long time with and without bichromate of potash?" "A method of determining butter fat in milk or cream by difference," and an abstract of an article on "The calculation of total solids in milk from the per cent of fat and the specific gravity, according to the formulas of Babcock, Fleischmann, and Hehner and Richmond, compared with the gravimetric method," by L. L. Van Slyke.

The twelfth annual report has a paper by C. G. Hopkins and W. A. Powers "On the determination of the acidity of milk and cream."

In the thirteenth report there is found a paper by J. M. Bartlett entitled "A modification of the Babcock method and apparatus for testing milk and cream."

Report for 1899.—As the results of suggestions made by Dr. L. L. Van Slyke and Prof. C. L. Penny, it was decided to repeat the work of last year and in addition compare the results from a method proposed by the referee of last year.

The following letter was sent to the chemists connected with the experiment stations:

Dear Sir: As referee on dairy products of the association, I would be very glad to have you cooperate in the work of this year. Should you find it convenient to aid in the work kindly let me know, and samples will be sent at any time that is the most convenient to you.

Yours, very respectfully, J. B. Weems.

To those who were willing to aid in the work, a sample of skim milk, containing formaldehyde to preserve it, was sent with the following outline of the methods for comparison:

ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.

METHODS OF THE ANALYSIS OF DAIRY PRODUCTS.

Your cooperation is respectfully requested in a comparison of the following methods for the determination of casein and albumin in milk:

I. *Casein in milk:*

(1) Modification of provisional method. (Acetic acid method. Circular 4, p. 3.) "Carry the method through as described to the washing of the precipitate, then neutralize the filtrate as exactly as possible with caustic alkali, then filter off any precipitate that may form and add it to the former precipitate for the nitrogen determination."

(2) Alum method. "To 10 cc of milk add 50 cc of water at 40°. Then add 1.5 cc of alum solution saturated at 40° or higher. If the precipitate fails to settle promptly, add 0.5 cc more of the alum solution, filter, wash with water, and use the Kjeldahl method for the determination of nitrogen."

II. *Albumin in milk:*

Modification of provisional method: "To the filtrate from the casein, according to either of the above methods, add 10 cc of strong tannin solution; heat, filter, wash with water, and determine nitrogen."

III. Dilute 60 cc of milk with 300 cc of distilled water in a 500 cc measuring flask, then add 10 cc of alum solution (see (2) alum method) to precipitate the casein, and fill to the mark. Filter off 50, 100, or 200 cc, as may be desired, and determine the nitrogen in the usual manner. Multiply the result by 6.25. Determine the total nitrogen in the sample of milk and multiply by 6.25 for total nitrogenous compounds present in the milk. From the result obtained for total nitrogenous compounds subtract the result obtained from the filtrate, and consider the difference as casein.

Methods I and II are a continuation of the work of last year. III is the method recommended by Mr. C. L. Penny as referee in his report of last year. In reporting results, kindly send all necessary data in order that full comparisons may be made.

J. B. WEEMS, *Referee.*

AMES, IOWA.

In connection with the above circular and for the convenience of those aiding in the work, it was decided to prepare three samples of skim milk to which enough formaldehyde was added to preserve the samples for the time necessary for transportation and analysis. Two of the samples were sent to the chemists connected with other stations, and the other kept for analysis in the station laboratory. Sample 1 was sent to six stations and sample 3 to five stations. To the present time returns have been received from eight stations, and with the work of this station are as follows:

SAMPLE NO. 1.

Analyst.	Casein.		Albumin.		Penny's method.		
	Modification of provisional method.	Alum method.	Modification of provisional method.	Alum method.	Total nitrogen × 6.25.	Casein.	Nitrogen in filtrate × 6.25.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
W. H. Heileman, Washington	2.377	2.300	0.445	0.471	3.080	2.547	0.533
C. L. Penny, Newark, Del	2.300	2.320	.460	.560	3.050	2.310	.740
W. B. Cady, Missouri	2.340	2.294	.515	.564	3.052	2.233	.810
Maurice Bird, Louisiana	2.450	2.410	....	.460	3.030	2.520	.490
J. A. LeClerc, Geneva, N. Y	2.390	2.340	.350	.460	3.030	2.380	.650
I. J. Mead, Ames, Iowa	2.160	2.190	.554	.533	2.912	2.079	.810
Highest	2.450	2.410	.554	.564	3.080	2.547	.810
Lowest	2.160	2.190	.350	.460	2.912	2.079	.490
Average	2.336	2.309	.4650	.508	3.0260	2.3450	.672

SAMPLE NO. 2.

Analyst.	Casein.		Albumin.		Penny's method.		
	Modification of provisional method.	Alum method.	Modification of provisional method.	Alum method.	Total nitrogen × 6.25.	Casein.	Nitrogen in filtrate × 6.25.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
I. J. Mead, Iowa	2.422	2.442	0.484	0.494	3.21	2.325	0.885
H. N. Grettenberg, Iowa	2.458	2.448	.516	.496	3.31	2.280	1.030
J. C. Brown, Iowa	2.488	2.426	.467	.540	3.25	2.252	.998
Highest	2.488	2.448	.516	.540	3.31	2.325	1.030
Lowest	2.422	2.426	.467	.494	3.21	2.252	.885
Average	2,456	2.438	.489	.510	3.26	2.283	.971

SAMPLE No. 3.

N. E. Wilson, Nevada	2.627	2.594	0.532	0.599	3.358	2.662	0.681
	2.627	2.594	.532	.599	3.358	2.662	.681
	2.627	2.594	.532	.599	3.358	....	....
	2.594	2.627	....	.632	....	....	....
	2.594	2.627	....	.632	....	....	....
	2.614	2.604	.532	.608	3.358	2.662	.681
O. W. Knight, Maine	2.690	2.630	.440	.560	3.380	2.940	.440
	2.630	2.560	....	.560	3.380	2.940	.440
	2.660	2.595	.440	.560	3.380	2.940	.440
A. J. Patten, Maine	2.620	2.560	....	.530	3.380	2.570	.810
	2.620	2.620	....	.520	3.440	2.630	.810
	2.620	2.590	....	.525	3.410	2.600	.810
E. W. Woll and Alfred Vivian, Wisconsin	2.670	2.670	.508	....	3.240	2.454	.786
	2.550	2.650	.549	....	3.390	2.603	.787
	2.590	2.620	.519	....	3.330	2.543	.787
		2.640					
	2.600	2.650	.525	....	3.320	2.533	.787
I. J. Mead, Iowa	2.489	2.479	.483	.530	3.300	2.501	.799
H. N. Grettenberg, Iowa	2.537	2.530	.522	.495	3.219	2.500	.719
J. C. Brown, Iowa	2.505	2.542	.456	.476	3.220	2.410	.810
Highest	2.660	2.650	.5323	.608	3.410	2.940	.810
Lowest	2.489	2.479	.440	.476	3.219	2.410	.440
Average	2.575	2.570	.492	.532	3.315	2.593	.720

If the results from the three samples be compared, we have the following:

	Modification of provisional method.	Alum method.	Penny's method.
Casein.	*Per cent.*	*Per cent.*	*Per cent.*
Sample 1, average of 6 results	2.336	2.309	2.344
Sample 2, average of 3 results	2.466	2.438	2.282
Sample 3, average of 7 results	2.575	2.570	2.593
Average of the 3 samples	2.459	2.436	2.406
Albumin.			
Sample 1, average of 6 results	0.464	0.508	0.672
Sample 2, average of 3 results	.489	.510	.971
Sample 3, average of 7 results	.492	.532	.721
Average of the 3 samples	.4816	.5166	787

As a result of the sixteen analyses of the three samples of milk we find in the determination of casein that there is a difference in the results of the modification of the provisional method and the alum method of 0.023 per cent, while the difference between the albumin results in the two methods is 0.035 per cent.

The time for the work of investigation being so short this year, the referee would prefer not to make any recommendations, but would suggest a continuation of the work next year, with the addition of other methods, in order that the subject may be investigated in a thorough manner and be made as complete as possible.

The president called for papers on this subject and also for discussion. Since the report contained no recommendations save that the work be continued along the same lines for another year, it was not referred to the committee on recommendations.

The president next called for the report of the committee on recommendations. Mr. C. D. Woods, the chairman of the committee, presented the report orally. Very few recommendations had been made by the referees, so that the work of the committee was comparatively light. In regard to the recommendations of the referee on fungicides and insecticides it was recommended that the methods of analysis, although not perfect, be suggested tentatively for the use of the members of the association, but that they should not in any sense be designated as official.

The president asked for a vote on this recommendation and it was unanimously adopted.

The recommendation of the referee on potash, with a slight modification of the method of solution, was recommended for further study, but not for adoption.

The report of the committee on recommendations was adopted without change.

The report of the abstract committee was next presented by Mr. Allen, and on motion was accepted.

REPORT OF THE COMMITTEE ON ABSTRACTING.

Mr. President and Members of the Association: The work of this committee was organized with as little delay as possible after its designation, and the following letter sent out by the chairman:

Washington, D. C., *January 16, 1899.*

——— ———,
——— ———.

Dear Sir: On account of several changes in the abstract committee since its designation at the meeting last November it has only just become possible to make an assignment of work for the year. This assignment, which I hope will prove agreeable to the members of the committee, I have made as follows:

E. W. Allen: Jour. Landw.; Milch Ztg.; abstracts in Analyst, Chem. Centrbl., Chem. Ztg. Repert.

J. T. Anderson: Chem. Ztg.; Jour. Chem. Soc. [London].

W. H. Beal: Compt. Rend.; Bul. Soc. Chim. Paris; Ztschr. Angew. Chem.; abstracts in Jour. Chem. Soc. [London].

E. B. Holland: Amer. Chem. Jour.; Analyst.

C. G. Jentner: Ztschr. Untersuch. Nahr. u. Genussmtl.; Ztschr. Physiol. Chem.

L. H. Merrill: Jour. Amer. Chem. Soc.; Jour. Franklin Inst.

Harry Snyder: Bul. Assoc. Belge Chim.; Rev. Chim. Analyt. et Appl.; Ann. Sci. Agron.

J. B. Street: Landw. Vers. Stat.; Ztschr. Analyt. Chem.

C. B. Williams: Jour. Soc. Chem. Ind.; Chem. News.

In taking up the work please begin with the numbers of the journals which you have received since January 1, 1899. It is very important that the journals should be followed systematically, otherwise important articles may fail of notice in the Experiment Station Record. To avoid this and to keep the work up to date, it has seemed best to have an understanding with the members of the committee that any numbers which have become two months in arrears will be abstracted in the Office of Experiment Stations—in other words, that if by force of circumstances you are prevented from abstracting your journals for a period you will know that any journals which you have had on hand for two months or more have been attended to in this office, and be governed accordingly in resuming the work. The cooperation of all members of the abstract committee is earnestly desired, and the object of the above arrangement is, as explained, merely to prevent any gaps in the work.

It will be understood that you are to abstract only such original articles in your journals as relate to methods and apparatus for agricultural analysis, not articles on general or industrial chemistry. For the form of statement of the abstract see Experiment Station Record. In giving the reference please state the name of the periodical, using the abbreviations given above, the volume number in figures, the year in parentheses, the number within the volume (No., Heft, Fasc., etc.), and the pages (beginning and end of the article) with the number of figures. Please take pains to give full references and to write all names and technical terms plainly. The abstracts should be signed by the abstracter.

I send you herewith a supply of franked envelopes to be used in sending in material. Others can be procured as needed.

Very respectfully, yours,

E. W. Allen, *Chairman.*

The work of abstracting has gone on with regularity, the abstracts being published in the numbers of the Experiment Station Record, as heretofore. On account of the shortened period of its work, due to the holding of the meeting of the association at an earlier date than usual, the aggregate amount of matter published has not been as great as formerly, but relatively it is believed there has been no falling off.

E. W. Allen,
J. T. Anderson,
W. H. Beal,
E. B. Holland,
C. G. Jentner,
L. H. Merrill,
Harry Snyder,
J. B. Street,
C. B. Williams,
Committee.

Mr. B. F. Kilgore then presented the report of the committee on volumetric standards. He remarked that this association was the first one in this country that had taken any action in regard to uniformity of standards. He had written to the secretary of the association last year in regard to bringing the action of the association before the Third International Congress of Applied Chemistry, which was held in Vienna, and he would ask the secretary later to give a brief report of what was done at that meeting. In his opinion the principal point to be considered was the fixing of a standard of temperature for this country. When in North Carolina he had found that the mean temperature of the working hours was 21.8°. In Mississippi he had made a determination of the mean temperature of the working hours for six months, and found it to be 22.9°. Often the temperature in his laboratory exceeded 30°, and this would make a great change in the volume of a liter flask.

The secretary was called upon to report briefly what was done in Vienna in regard to standards. He stated that the communication of Mr. Kilgore was brought officially before the section on standard measures for sugar analysis. Attention was called to the fact that the temperatures in the United States were often very much higher than in Europe. In the laboratory at Washington a temperature of 40° had frequently been attained.

Mr. Frear called attention to the fact that when he worked in the laboratory at Washington a temperature of more than 40° was obtained in a room where a muffle furnace was used.

The secretary stated that without any artificial heat it was not unusual in the summer time for the laboratory to be at blood heat or above. The congress at Vienna voted unanimously to adopt the absolute standard of measure, and to discontinue the use of the so-called Mohr liter as soon as possible.

The secretary said that the Mohr liter was true to name in more than one respect, since it was not only Mohr, but *more*, containing 1,002.3 cubic centimeters.

Mr. Kilgore called attention to the fact that a Mohr liter which had been standardized at a temperature of 17½° would hold nearly 4 cc more at 30° than a true liter flask at 17½°.

The secretary said that in this country we were rapidly achieving success in the manufacture of instruments of precision. We already made the best standard measurements of length in the world, and the microscopes which were made in Rochester rivaled those manufactured by Zeiss. Lately Bausch & Lomb, of Rochester, had sent to Washington a complete set of volumetric apparatus which they guaranteed to be exact. There was, however, no mark on any piece of the set which would indicate the temperature at which it was standardized, and, therefore, without recalibration such a set of apparatus would be of little utility. It was evident, the secretary said, that the standard for volumetric apparatus in this country should be fixed at a higher temperature than 17½°, and the temperature of 22° or 23° was suggested as being a convenient one.

On motion, the report of the committee on volumetric standards was accepted and the committee continued for further corroborative work.

The president then called for the report of the committee on nominations. The report was presented by the chairman, Mr. William Frear, and is as follows:

REPORT OF COMMITTEE ON NOMINATIONS.

Gentlemen of the Association of Official Agriculturists: Your committee on nominations respectfully recommend for election to the several elective offices of this association the following-named gentlemen:

For president, Mr. B. W. Kilgore, of North Carolina.

For vice-president, Mr. L. L. Van Slyke, of New York.

For secretary, Mr. H. W. Wiley, of Washington, D. C.

For additional members of the executive committee, Mr. M.E. Jaffa, of California, and Mr. Arthur Goss, of New Mexico.

Respectfully submitted.

William Frear, *Chairman.*

On motion, the secretary of the association was directed to cast the ballot of the association for the nominees above mentioned. The secretary thereupon cast the ballot for the association and reported the gentlemen nominated for the several offices unanimously elected thereto.

The report of the committee on food standards was then called for.

The secretary stated that as chairman of the committee he had asked Dr. Frear, who was chairman of the subcommittee on standards, to prepare and present the report, which is as follows:

REPORT OF THE COMMITTEE ON FOOD STANDARDS.

Gentlemen: Your committee appointed at the convention of 1897 to consider the feasibility of fixing a set of pure-food standards, and empowered at that time to institute, without further action on the part of this association, such coöperative work as it deemed wise, to the end that a set of such standards might be formulated for the adoption of the association, respectfully reports that during the past year work has been conducted along the lines indicated in the report of this committee at the meeting of 1898 (Bulletin 56, Div. of Chem., U. S. Dept. Agr., pp. 128–130). From the subcommittee appointed by this committee to consider the subject of classification and standards it is reported that Mr. A. L. Winton, of the Connecticut Station, has completed the chemical examination of a large series of imported spices sampled by him from the original packages; that Prof. F. W. Woll has completed the chemical examination of sixty samples of American and Canadian dairy and table salts, and has compiled a large number of analyses of these materials made by other chemists; that Dr. L. L. Van Slyke has gathered most of the material needful for the fixing of standards for American dairy products; that Dr. J. B. Lindsey, whose serious illness has prevented the formulation of his report, has gathered much of the data needful for the formulation of standards for grains and their products, including cattle foods; that Prof. M. A. Scovell reports the accumulation of most of the needful data for standards for sugars and related substances; that Prof. H. A. Huston reports that he has gathered together much of the needful evidence respecting substances artificially introduced with possible injury to health; that Prof. William Frear has made a considerable number of analyses of vinegars, and compiled data upon that subject.

The rather short notice of the present meeting and the unusually brief interval that has elapsed since the last meeting have made the completion of the work of your committee to the point of formulating a set of standards for your consideration at this time impracticable. The work has, however, so far advanced that, in the judgment of your committee, it will be possible within a very short time to formulate, under certain broad canons of standardization, a set of standards for the more important foods of man and domestic animals.

Since the last meeting of this association the Congress of the United States, in considering that national measure for the prevention of misbranding and adulteration of foods and drugs indorsed by the National Pure Food and Drug Congress, and known in the United States Senate as the Faulkner bill, and in the United States House of Representatives as the Brosius bill, has, through its favorable report by the Committee on Agriculture of the Senate, and the favorable consideration by the House Committee on Interstate Commerce, distinctly indicated this association as the proper official advisory body with reference to the chemical aspects of food standards. It has been suggested by legal authorities in Congress that, in view of prospective early legislation for the establishing of national control of interstate commerce in foods and drugs, it is highly desirable that this association should, as promptly as existing information may make it possible to fix standards of strength and purity, prepare and publish such a set of standards to serve as a guide in the case of foods, just as the United States Pharmacopœia does in the case of drugs, since reference to such standards in the course of the legislation indicated may prove desirable.

In view of the present forward condition of the work assigned to it, so far as it affects the formulation of standards, and of the present need for the adoption of a set of such standards, your committee respectfully recommends that it be authorized to prepare and publish in the name of this association, and as soon after this meeting as it is found practicable, a set of such standards as it can satisfactorily formulate.

Respectfully submitted.

H. W. Wiley,
W. H. Scovell,
E. H. Jenkins,
William Frear,
Committee.

July 6, 1899.

The secretary said, in discussing the report of the committee, that the matter under consideration was one of the greatest importance which had ever come before the association. The importance of fixing standards of value for human foods was a work of great magnitude and of the highest significance from a legal aspect. The people of this country not only were entitled to protection against fraud in foods, but in order to preserve our foreign markets it is absolutely necessary that a system of national inspection be inaugurated. The nations of Europe are constantly seeking some pretext to close their markets against American food products. If commerce in adulterated foods be allowed to go on unrestricted in this country, the nations of Europe may have an apparently just cause for such exclusion. If the nations of Europe levy a duty on food products sent to their country, no just cause of complaint exists, because this duty rests equally upon all outside nations. When, however, a discrimination is made against the products of one country on the ground that they are injurious to health or adulterated, such discrimination becomes unbearable when the facts of the case do not justify it. An instance of this is seen in the closing, or partial closing, of the German markets to American pork. Dr. Stiles, the agricultural attaché of the American legation at Berlin, has investigated all the cases of trichinosis which have been reported since his residence in Berlin. In every case he found that the allegation that the attack was caused by American pork was false. In not a single instance had any American pork been eaten. It is evident, therefore, that the exclusion of our meat products on the alleged ground that they contain trichinæ is an unjust discrimination. Lately hundreds of newspapers in Europe have published a statement, attributed to me, that 90 per cent of all the food products of this country are adulterated. This statement arose from my testimony before the Senate Committee on Commerce in Chicago to this effect, namely, that 90 per cent of all food products had at some time or other been the subject of adulteration. Thus every possible pretext for excluding American food products is employed to our disadvantage. The Congress of the United States has officially recognized this association as the authority on the subject of adulterated foods and food standards. It is therefore of the utmost importance that the labors of the committee be completed at as early a date as possible. To this end I venture to ask this association to authorize this committee to complete its report, and that when its report is finished it be published and accepted as the official action of this association.

Mr. Jenkins offered the following resolution:

Resolved, That the report of the committee on food standards, as soon as completed, be accepted by this association and referred to the executive committee, and when indorsed by the executive committee be accepted as the authoritative report of this association.

The motion was unanimously carried.

The reports of the committees on rewriting methods of soil analysis and on rewriting Bulletin No. 46, were presented, as follows:

REPORT OF THE COMMITTEE ON REWRITING METHODS OF SOIL ANALYSIS.

The committee on the rewriting of methods of soil analysis begs to report that the methods of soil analysis were rewritten by the secretary in harmony with the authorization given at the last meeting of the association, and are published as a part of Bulletin No. 46 (revised).

Respectfully,

M. A. Scovell,
A. M. Peter,
H. W. Wiley,
Committee.

REPORT OF THE COMMITTEE ON THE REWRITING OF BULLETIN NO. 46.

I beg to submit the following report:

The whole of Bulletin No. 46 was carefully revised and rewritten, inserting the various amendments which have been made from time to time during the past three years, condensing the methods of analysis in some cases and slightly changing the phraseology in others, without, however, making alterations in the methods themselves, as ratified by the association, as a whole or in part. A large number of members were consulted by correspondence and otherwise in the revision of the work.

Bulletin No. 46, revised, is now offered as a full report of this committee.

Respectfully,

H. W. Wiley, *Committee.*

The secretary offered the following resolution:

Resolved, That the thanks of this association be extended to the various committees who have been instrumental in entertaining the Association of Official Agricultural Chemists during its meeting here, and especially to Mr. M. E. Jaffa, who has so earnestly and faithfully labored to make our entertainment pleasant, and our stay an agreeable one.

The resolution was unanimously adopted, and the secretary was authorized to make suitable acknowledgments in writing for the many courtesies the associations had received.

The secretary offered the following resolution:

Resolved, That the thanks of this association are hereby tendered to our retiring president, Dr. R. C. Kedzie, for the faithful and efficient manner in which he has discharged the duties of his position, and especially for the able and eloquent address which he delivered as president of the association.

Mr. B. W. Kilgore, the president elect, presented this motion to the association, and it was unanimously adopted.

The president then called upon the president elect for any announcements which he might have to make in regard to the appointment of referees and committees.

The president elect (Mr. Kilgore) stated that he had not had time to consider the matter, and therefore was unable to make any announcements at present. He would carefully consider all questions, and especially the resolution which had been passed recommending him to continue the referees and associate referees without change. In so far as this could be accomplished he would do so. He would communicate to the secretary later the names of the referees, associate referees, and the various committees authorized by the constitution and by resolution.

There being no further business, the association adjourned at 12.30 o'clock, subject to the call of the executive committee.

OFFICERS, REFEREES, AND COMMITTEES OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS FOR THE YEAR 1900.

President.

Mr. B. W. Kilgore, Raleigh, N. C.

Vice-President.

Mr. L. L. Van Slyke, Geneva, N. Y.

Secretary.

Mr. H. W. Wiley, Washington, D. C.

Additional Members of Executive Committee.

Mr. M. E. Jaffa, Berkeley, Cal.
Mr. Arthur Goss, Mesilla Park, N. Mex.

Referees.

Phosphoric acid.—Mr. E. G. Runyan, Washington, D. C.
Nitrogen.—Mr. F. S. Shiver, Clemson College, S. C.
Potash.—Mr. B. B. Ross, Auburn, Ala.
Soils.—Mr. B. L. Hartwell, Kingston, R. I.
Dairy products.—Mr. J. B. Weems, Ames, Iowa.
Foods and feeding stuffs.—Mr. Thorn Smith, Moscow, Idaho.
Liquor and food adulteration.—Mr. H. A. Weber, Columbus, Ohio.
Sugar.—Mr. R. E. Blouin, New Orleans, La.
Tannin.—Mr. Oma Carr, Lynchburg, Va.
Insecticides.—Mr. E. A. de Schweinitz, Washington, D. C.
Ash.—Mr. A. E. Shuttleworth, Guelph, Canada.

Associate Referees.

Phosphoric acid.—Mr. H. K. Miller, Lake City, Fla.
Nitrogen.—Mr. W. R. Perkins, Agricultural College, Miss.
Potash.—Mr. L. S. Munson, Washington, D. C.
Soils.—Mr. M. E. Jaffa, Berkeley, Cal.
Dairy products.—Mr. F. W. Woll, Madison, Wis.
Foods and feeding stuffs.—Mr. C. A. Browne, jr., State College, Pa.
Liquor and food adulteration.—Mr. W. D. Bigelow, Washington, D. C.
Sugar.—Mr. G. L. Spencer, Washington, D. C.
Tannin.—Mr. E. J. Haley, Ridgway, Pa.
Insecticides.—Mr. L. A. Voorhees, New Brunswick, N. J.
Ash.—Mr. G. S. Fraps, Raleigh, N. C.

Abstract Committee.

Mr. E. W. Allen, Washington, D. C., chairman.
Mr. W. H. Beal, Washington, D. C.
Mr. G. W. Shaw, Corvallis, Oreg.
Mr. J. T. Anderson, Auburn, Ala.
Mr. J. P. Street, New Brunswick, N. J.
Mr. W. F. Hand, Agricultural College, Miss.
Mr. R. E. Blouin, New Orleans, La.
Mr Harry Snyder, St. Anthony Park, Minn.
Mr. C. B. Williams, Raleigh. N. C.

Committee on Food Standards.

Mr. H. W. Wiley, Washington, D. C., chairman.
Mr. H. A. Weber, Columbus, Ohio.
Mr. M. A. Scovell, Lexington, Ky.
Mr. E. H. Jenkins, New Haven, Conn.
Mr. William Frear, State College, Pa.

Committee on Fertilizer Legislation.

Mr. H. W. Wiley, Washington, D. C., chairman.
Mr. B. W. Kilgore, Raleigh. N. C.
Mr. H. B. McDonnell, College Park, Md.
Mr. H. A. Huston, Lafayette, Ind.
Mr. B. B. Ross, Auburn, Ala.

Committee on Volumetric Standards.

Mr. B. W. Kilgore, Raleigh, N. C., chairman.
Mr. C. L. Penny, Newark, Del.
Mr. E. E. Ewell, Washington, D. C.
Mr G. C. Caldwell, Ithaca, N. Y.
Mr. H. W. Wiley, Washington, D. C.

CONSTITUTION OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.

(1) This association shall be known as the Association of Official Agricultural Chemists of the United States. The objects of the association shall be (1) to secure uniformity and accuracy in the methods, results, and modes of statements of analysis of fertilizers, soils, cattle foods, dairy products, and other materials connected with agricultural industry; (2) to afford opportunity for the discussion of matters of interest to agricultural chemists.

(2) Analytical chemists connected with the United States Department of Agriculture, or with any State or national agricultural experiment station or agricultural college, or with any State or national institution or body charged with official control of the materials named in section 1, shall alone be eligible to membership; and one such representative for each of these institutions or boards, when properly accredited, shall be entitled to enter motions or vote in the association. Only such chemists as are connected with institutions exercising official fertilizer control shall vote on questions involving methods of analyzing fertilizers. Any person eligible to membership may become a member at any meeting of the association by presenting proper credentials and signing this constitution. All members of the association who lose their right to such membership by retiring from positions indicated as requisite for membership shall be entitled to become honorary members, and to have all privileges of membership, save the right to hold office and vote. All analytical chemists and others interested in the objects of the association may attend its meetings and take part in its discussions, but shall not be entitled to enter motions or vote.

(3) The officers of the association shall consist of a president, a vice-president, and a secretary, who shall also act as treasurer; and these officers, together with two other members to be elected by the association, shall constitute the executive committee. When any officer ceases to be a member by reason of withdrawing from a department or board whose members are eligible to membership, his office shall be considered vacant, and a successor may be appointed by the executive committee, to continue in office till the annual meeting next following.

(4) There shall be appointed by the president, at the regular annual meeting, a referee and associate referee for each of the subjects to be considered by the association.

It shall be the duty of these referees to prepare and distribute samples and standard reagents to members of the association and others desiring the same; to furnish blanks for tabulating analyses, and to present at the annual meeting the results of work done, discussion thereof, and recommendations of methods to be followed.

(5) The special duties of the officers of the association shall be further defined, when necessary, by the executive committee.

(6) The annual meeting of this association shall be held at such place as shall be decided by the association, and at such time as shall be decided by the executive committee, and announced at least three months before the time of meeting.

(7) No changes shall be made in the methods of fertilizer analyses, except by unanimous consent, until an opportunity shall have been given all official chemists having charge of fertilizer work to test the proposed changes.

(8) Special meetings shall be called by the executive committee when in its judgment it shall be necessary, or on the written request of five members; and at any meeting, regular or special, seven enrolled members entitled to vote shall constitute a quorum for the transaction of business.

(9) The executive committee will confer with the official boards represented with reference to the payment of expenses connected with the meetings and publication of the proceedings of the association.

(10) All proposed alterations or amendments to this constitution shall be referred to a select committee of three at a regular meeting, and after report from such committee may be adopted by the approval of two-thirds of the members present entitled to vote.

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